Instruments

THE MAGAZINE OF

Measurement and Control

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No. 4

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INCLUDING *Aviation Instruments*

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Deviations from the Norm • • • When The Occur • • • Their Duration and Extent • • • Precisely Recorded by • • •

BAROMETERS
Mercurial

CONTROLLERS
Flow
Humidity
pH
Liquid Level
Pressure
Temperature
Vacuum

FLOW INSTRUMENTS
Controllers
Indicators
Integrators
Meters
Recorders

GAGES, RECORDING
Pressure
Temperature
Vacuum

HYDROMETERS

HYGROMETERS
Wet & Dry Bulb Thermometers

LIQUID LEVEL
Controllers
Indicators
Recorders

MERCURIAL GAGES
Absolute Pressure
Mercurial Vacuum

MOISTURE METERS
Grains, Tobacco, Wood, Granular Material

OIL TESTING INSTRUMENTS

POTENTIOMETERS
Controlling
Indicating
Recording

PYROMETERS
Controlling
Indicating
Recording
Resistance
Thermoelectric

RECORDERS
Electric
Flow
Humidity
pH
Hygrometer
Liquid Level
Pressure
Psychrometers
Temperature
Time-Operation
Vacuum

STEAM TRAPS

THERMOMETERS
Chemical
Dial
Electric
Expansion Stem
Indicating
Industrial
Recording
Resistance

VALVES
Diaphragm
Reducing
V-Port
Three-Way

TAG

RECORDING PRESSURE GAGES

In war production it is not enough that a pressure gage merely show fluctuations . . . it must tell WHEN . . . HOW LONG . . . HOW MUCH. Then, and only then can process control be exercised consistent with war production standards.

The *continuous* record — the complete story told by the TAG Recording Pressure Gages — is quite as important in the post-war production picture as it is today. The potential savings in materials and uniformity through improved process efficiency are of material interest.

The convenient listing at the left includes many instruments on which you should have data. A letter will bring full information.

TAG RECORDING PRESSURE GAGES

TAG RECORDING INSTRUMENTS for Temperature and Pressure
TAG

These moderately priced instruments are carefully designed, accurately calibrated and are available in 3 sizes —utilizing 9″—10″ and 12″ charts. Catalog No. 1210-I gives all the facts—and in addition to full information on TAG Pressure Gages — illustrates and describes TAG Recording Thermometers.

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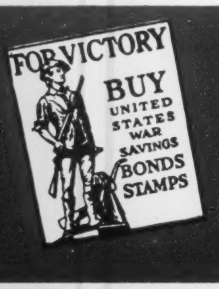
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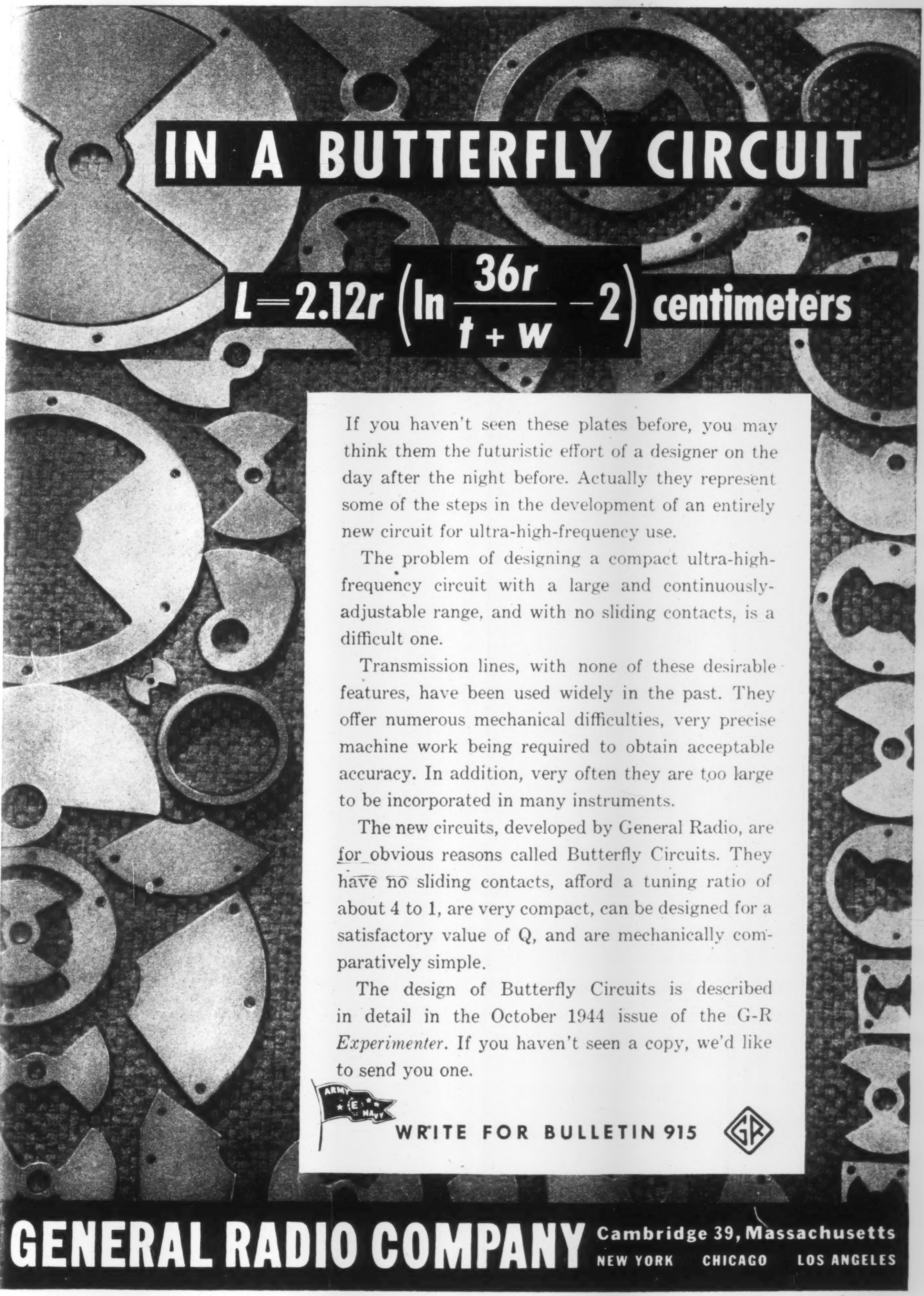

IN A BUTTERFLY CIRCUIT

$$L = 2.12r\left(\ln\frac{36r}{t+w} - 2\right)\ \text{centimeters}$$

If you haven't seen these plates before, you may think them the futuristic effort of a designer on the day after the night before. Actually they represent some of the steps in the development of an entirely new circuit for ultra-high-frequency use.

The problem of designing a compact ultra-high-frequency circuit with a large and continuously-adjustable range, and with no sliding contacts, is a difficult one.

Transmission lines, with none of these desirable features, have been used widely in the past. They offer numerous mechanical difficulties, very precise machine work being required to obtain acceptable accuracy. In addition, very often they are too large to be incorporated in many instruments.

The new circuits, developed by General Radio, are for obvious reasons called Butterfly Circuits. They have no sliding contacts, afford a tuning ratio of about 4 to 1, are very compact, can be designed for a satisfactory value of Q, and are mechanically comparatively simple.

The design of Butterfly Circuits is described in detail in the October 1944 issue of the G-R *Experimenter*. If you haven't seen a copy, we'd like to send you one.

ARMY E NAVY

WRITE FOR BULLETIN 915

GR

GENERAL RADIO COMPANY Cambridge 39, Massachusetts
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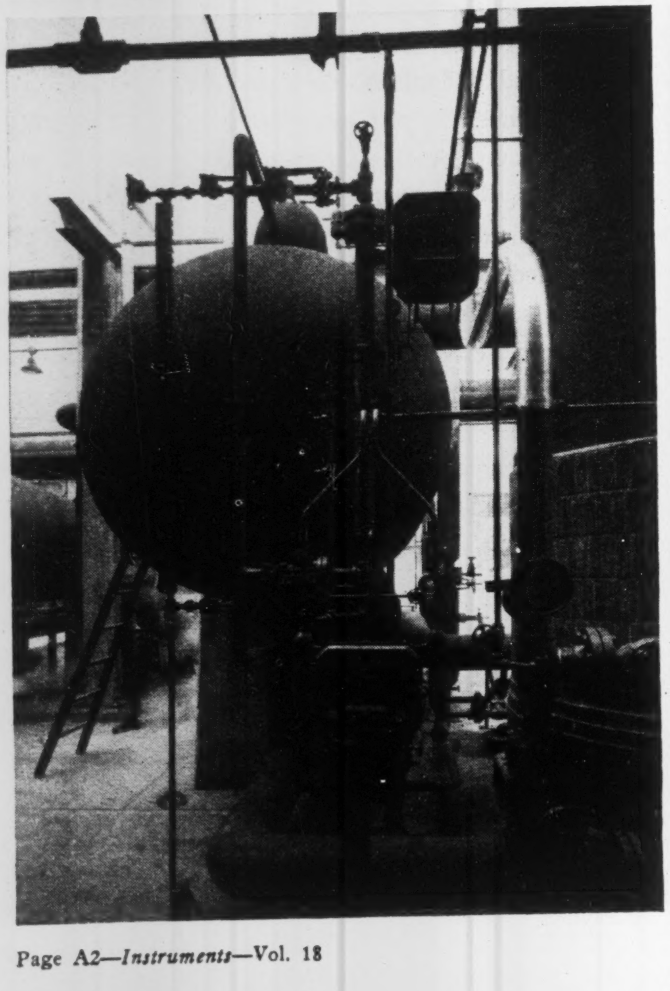
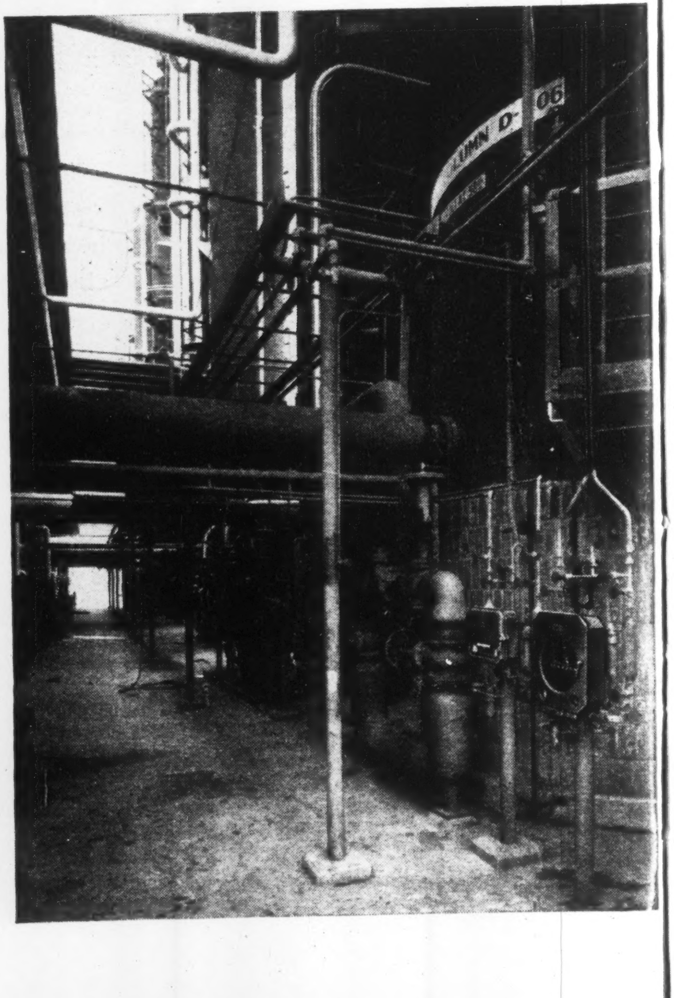
LATEST FASHIONS IN





INSTRUMENTATION

Photos from new Union Oil Plant show latest Taylor developments

THESE pictures from the Union Oil Company's new plant, built by The Lummus Company and C. F. Braun & Co., show some of the latest developments in instrument control of aviation gasoline production.

Here's a partial list of the many varieties of Flow, Liquid Level, Pressure and Temperature instruments supplied. It's an interesting demonstration of the breadth of Taylor's services and the versatility of the Fulscope Controller mechanism:

REMOTE PNEUMATIC TRANSMISSION SYSTEMS—utilizing both Mercury—and Aneroid—manometer Flow transmitters; Internal-float and "Levelbuoy" Buoyancy type Level transmitters; and Pressure transmitters . . . For some Pressure and Level applications *both* Transmission and Control were incorporated in the same instrument at the point of measurement (see upper instrument in lower left photo).

Receivers are Recording Controller with Automatic Reset, and plain Recorders with 1 or 2 pens.

FLOW CONTROLLERS— Mercury type with Automatic Reset.

PRESSURE CONTROLLERS AND RECORDERS in Compressor Plant (see photo at left below).

PNEUMATIC-SET CONTROLLERS— Liquid level resetting Flow.

LIQUID LEVEL CONTROLLERS—both Internal-float and "Levelbuoy" Buoyancy types.

TEMPERATURE CONTROLLERS—with "Accuratus" (temperature compensated) mercury tube systems and "Thermospeed" Separable Well constructions.

AUTOMATIC-MANUAL BY-PASS—in both Internal and External forms.

"PRECISOR" VALVE POSITIONERS.

SELF-ACTING TEMPERATURE CONTROLLERS.

The moral is obvious: *We want to work with you on your new and modernization projects, too!* Call your nearest Taylor Field Engineer. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

ARMY E NAVY

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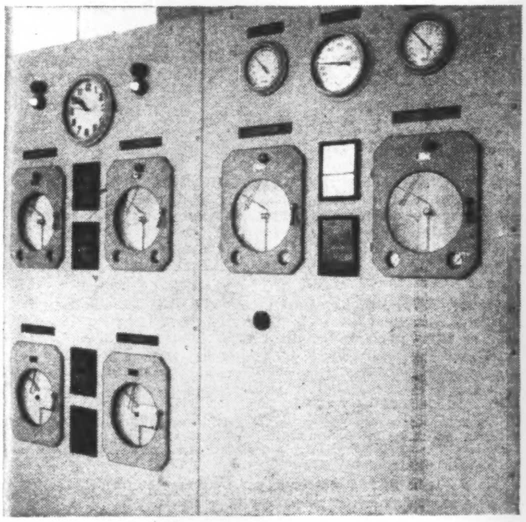
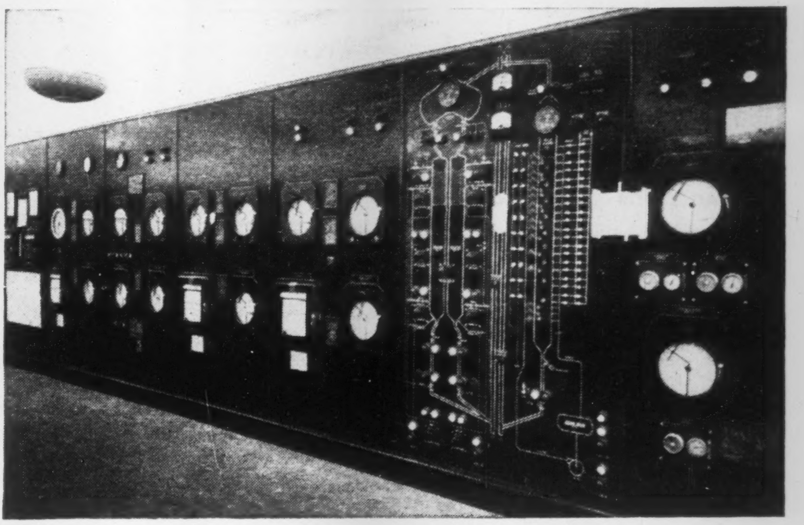
ACCURACY FIRST
IN HOME AND INDUSTRY





How a 40-dollar ELGIN Sapphire Gage saved Stewart-Warner $4,000 PLUS!

ELGIN
.3000
1304 NO GO

Still showing less than .00001 inch wear, well within tolerance limits, an Elgin Sapphire Plug Gage has delivered the incredible total of 158,220 close tolerances gagings! Hi-speed *steel* gages, formerly used, wore beyond tolerance use after only 300 gagings! The startling contrast in *gage* cost for 158,220 gagings is shown below:

Gage	Gages required	Cost	Total Cost
Steel	527	$8.00 ea.	$4,216.00
Elgin	1	40.00 ea.	40.00
		SAVINGS—	$4,176.00

This tremendous saving is only for *one* of many gages on this job at Stewart-Warner—many Elgin Sapphire Gages are in continuous use at the plant.

The dimensional fidelity of Elgin Gages saves money, too, by *eliminating* worn-gage rejects. Chemically inert at normal temperatures, their contact points of sapphire do not rust, corrode, burr or become distorted with use.

Write for prices and information on Elgin Sapphire Plug and Ring Gages.

ELGIN SAPPHIRE PRODUCTS PRESENT MANY ADVANTAGES FOR THE FOLLOWING TYPES OF EQUIPMENT:

Gages • Bearings • Thread Guides • Extrusion Dies • Knife Edges • Spray Nozzles • Diesel Injector Nozzles • Soft Wire Dies • Burnishing Tools • Pressure Vessel Windows • Watch Crystals • Honing Stones.

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Instruments

Vol. 18 APRIL 1945 No. 4

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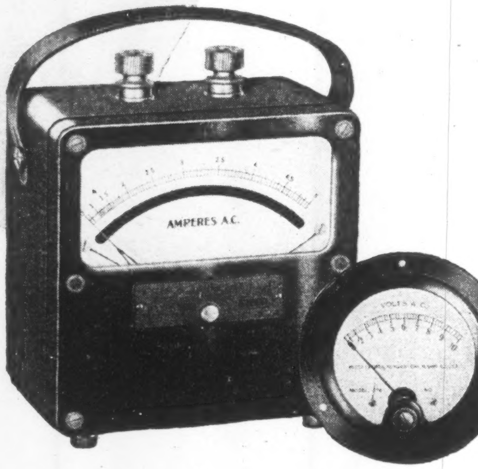

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FREQUENCY COMPENSATED INSTRUMENTS

This is another WESTON contribution born of war's needs, wherein the growing use of equipment operating in the higher power frequency range necessitated instruments of *broad flexibility* plus the *rugged dependability* which moving iron vane and dynamometer instruments provide.

And throughout industry today, the growing use of power frequencies above 60 cycles, with the smaller transformers, higher speed motors, simpler rectifier filter systems, makes the use of these instruments essential for their dependable indications and for their economy as well.

Weston is furnishing these instruments as ammeters, voltmeters, and wattmeters, in both portable and switchboard types; flat compensated up to 1000 . . . 2000 . . . 3000 cycles for general laboratory use, as well as for specific application to electronic and power apparatus. Weston Electrical Instrument Corporation, 591 Frelinghuysen Avenue, Newark 5, N. J.

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American industry has been quick to utilize the new Dow Corning Silicones—to see the potentialities inherent in their higher order of heat stability, chemical inertness, water resistance, and dielectric properties. Dow Corning is now supplying, directly or through selected distributors, the following silicone products:

FLUIDS Water-white, odorless, inert Silicone Liquids . . . notable for their low rate of viscosity change over a wide temperature range, low vapor pressure, water repellency, and good dielectric properties.

4 Ignition Sealing Compound . . . an easily applied silicone waterproofing compound having excellent dielectric properties, corona resistance, and the consistency of petroleum jelly. It neither hardens nor melts at temperatures ranging from −40° F. to 400° F.

7 Special Low Temperature Compound . . . an oxidation resistant lubricant and sealing compound developed for use at temperatures as low as −70° F.

31 A lubricating Silicone Grease for special applications in the temperature range of −70° F. to 190° F.

41 A lubricating Silicone Grease for special applications where operating temperatures range from 0° F. to 400° F.

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993 Insulating Varnish . . . recommended because of its extreme heat stability for impregnating, coating and bonding, and waterproofing inorganic insulating materials such as asbestos, mica, and Fiberglas cloth, tape, and sleeving. Other special purpose silicone resins and compounds are available.

STOPCOCK GREASE

A chemically resistant Silicone Grease for lubricating stopcocks and other ground glass joints.

PLUG COCK GREASE

A Silicone Grease that affords easy operation of lubricated plug valves over wide temperature ranges in most difficult services.

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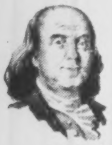
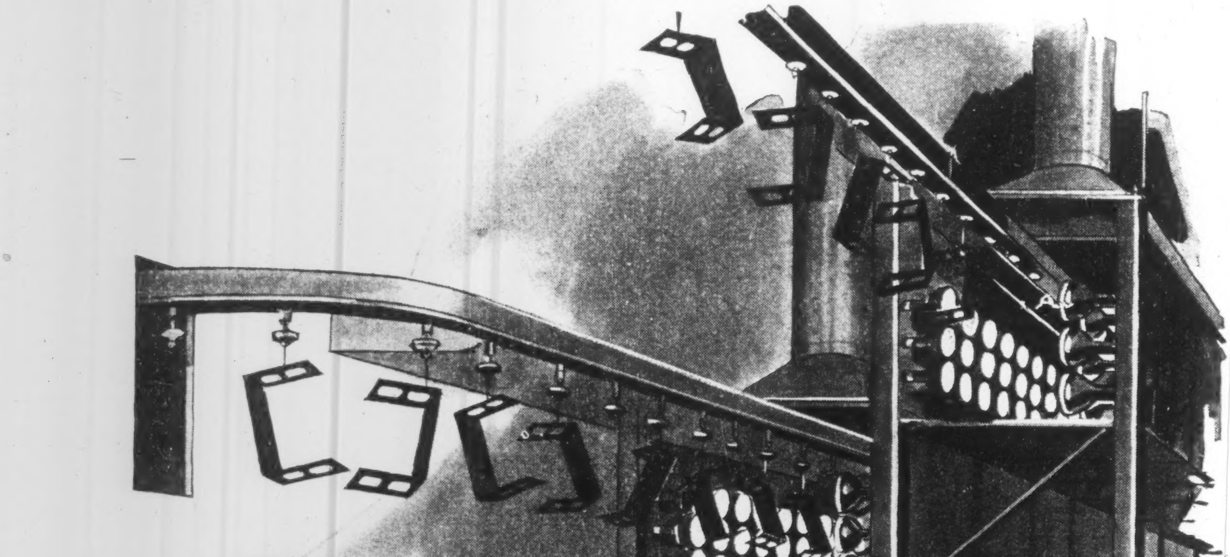


"DO NOT SQUANDER TIME"

. . . Benjamin Franklin

At Connecticut Telephone and Electric Division, production is unhurried, as it must be to maintain accuracy and quality in precision electrical and electronic manufacturing. We substitute *time-saving* methods for *hustle and bustle*. This has enabled us to keep abreast of the ever-increasing need for military communicating equipment of uniform dependability.

After the war, you will very likely use electrical equipment, electronic devices, or communicating systems made at Connecticut Telephone and Electric Division . . . Or you may be one of the many manufacturers who will use our engineering and manufacturing facilities in connection with your own products . . . In either case, our time-saving methods will be your gain, measured by the important standards of uniform high precision, and speed of filling your orders.



Freshly painted telephone chassis run the gantlet of automatically controlled infra-red dryers, which cut drying time to half an hour. This system, designed by our own engineers, is one of many examples of time-saving installation throughout the Connecticut Telephone & Electric Division plant.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

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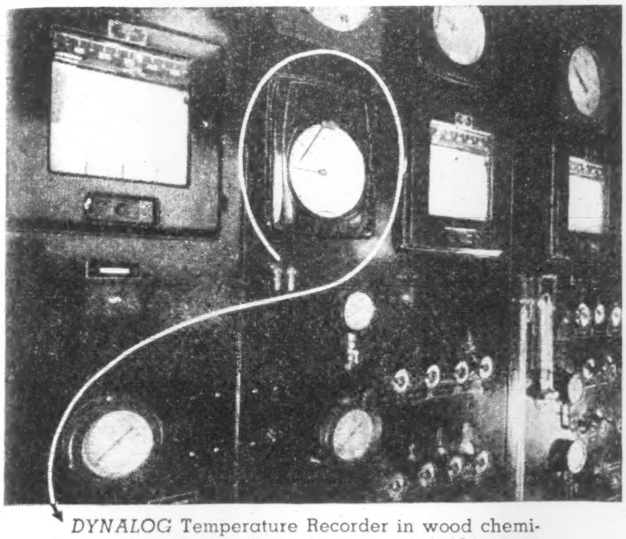
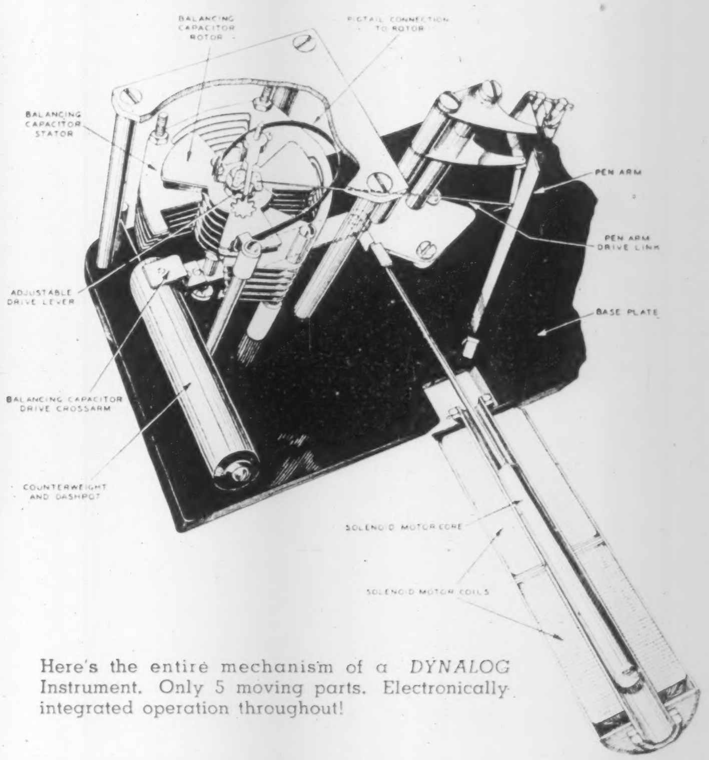
far beyond usual requirements for TEMPERATURE MEASUREMENT!



DYNALOG Temperature Recorder in wood chemicals plant. Entire chart range is only 12°C. Full-scale pen travel requires only 3 seconds.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Here's the entire mechanism of a *DYNALOG* Instrument. Only 5 moving parts. Electronically integrated operation throughout!

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At a single stroke, Foxboro's development of *DYNALOG* Electronic Instruments has smashed all previous standards of combined speed and accuracy for industrial production instruments. It now makes available Temperature Recorders and Indicators with the same high accuracy for *narrow* scales, that previous instruments could offer only for *wide* scales!

Three typical *DYNALOG* Recorder installations show what this can mean to exacting processes:

In a Wood Chemicals Plant, necessary purity and quantity of output demand very accurate measurement of vapor temperature in batch distillation. A *DYNALOG* Temperature Recorder with full scale only 12°C. wide was specified. Its performance was so accurate and reliable that a second was ordered when the process was expanded.

A Leading Rubber Processor now uses a portable *DYNALOG* Temperature-Difference Recorder to check production processes with laboratory precision. Temperature-difference between heat exchange liquid to and from the reactor is measured speedily and accurately. Interchangeable ranges of 5°F., 20°F. and 100°F. adapt this instrument to widely varied testing.

In Pre-Testing Warplane Equipment, stratosphere test-chamber temperature is dropped from +70°F. to −70°F. in 3 minutes. *DYNALOG* Temperature Recorders and Indicators follow these rapid changes accurately with less than 1/5 the lag of mechanical instruments.

If your processes require such unprecedented performance in a temperature instrument, call in a Foxboro Engineer. *DYNALOG* Temperature Recorders and Multiple-Point Indicators are available for 8-week delivery on AA1 rating. **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U. S. A.**

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HOW TO SELECT A ROTAMETER FOR YOUR SERVICE
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Announcing

the SECOND U.S.-made "Megger" Instrument
. . . THE MIDGET "MEGGER"* INSULATION TESTER

Following the production, in June 1943, of the first U. S.-made "Megger" testers, we now announce a second "Megger" instrument being built in our Philadelphia factory—the Midget "Megger" Insulation Tester.

This new U. S. model is identical in design and similar in every way to the Midget "Megger" Insulation Testers we have been supplying for the past ten years, except that the molded plastic housing is mottled brown instead of red.

The Midget "Megger" Tester has achieved wide popularity because of its size and low cost. Weighing but 3-pounds, it is always ready to use for testing insulation resistance of a wide variety of electrical equipment. It is indispensable for maintenance and trouble shooting, even where higher range "Megger" testers can be used . . . reads up to 50 megohms and delivers 500 volts d-c from a hand-cranked generator, making it independent of batteries or external power supply. Lower ratings are also available.

Manufacturing facilities are complete and our expanding production makes availability of these new instruments far better than we have previously been able to offer. We invite your orders for them.

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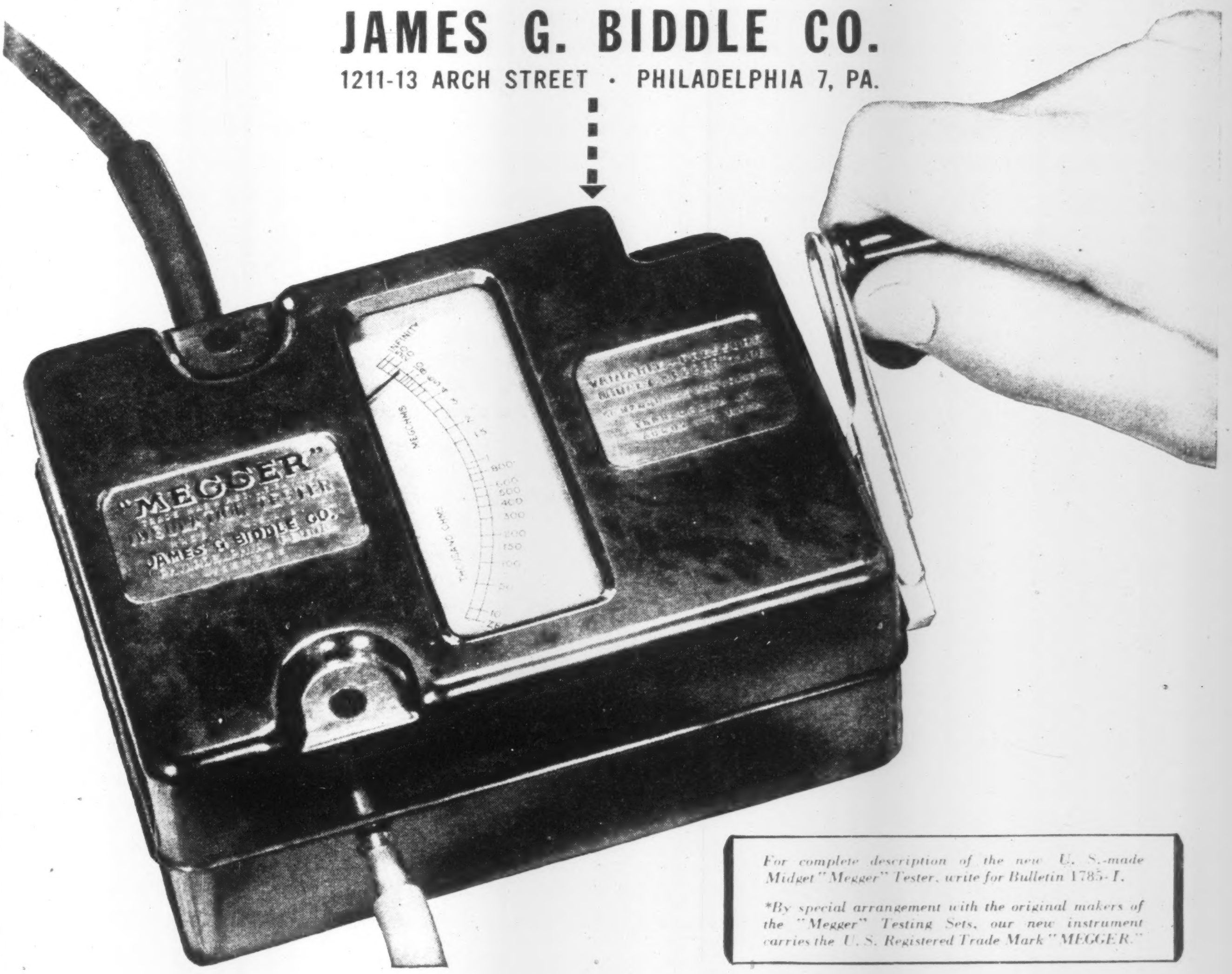
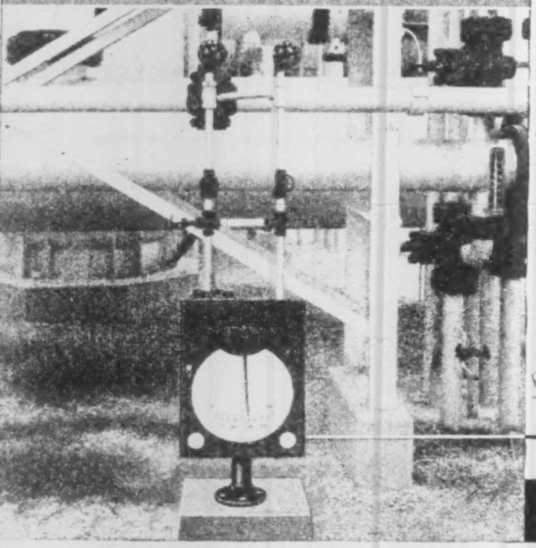


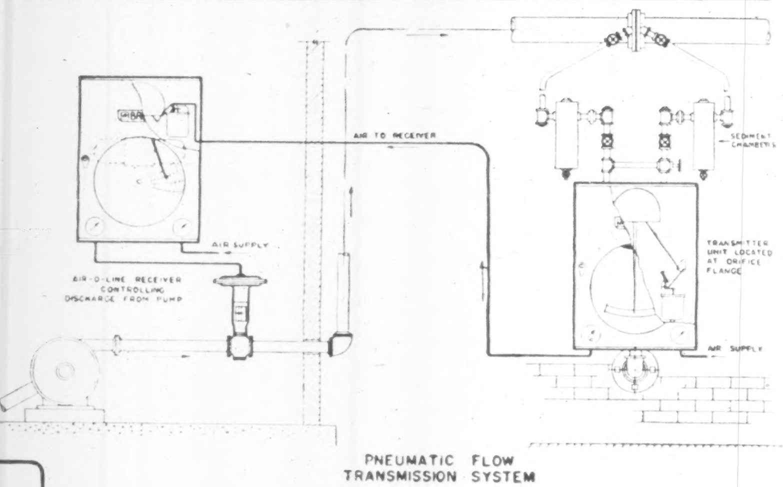
For complete description of the new U. S.-made Midget "Megger" Tester, write for Bulletin 1785-I.

**By special arrangement with the original makers of the "Megger" Testing Sets, our new instrument carries the U. S. Registered Trade Mark "MEGGER."*

Centralize REMOTE MEASUREMENT AND CONTROL *with Safety*



Indicating transmitter located at remote point of measurement.


AIR TO RECEIVER
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AIR-O-LINE RECEIVER CONTROLLING DISCHARGE FROM PUMP
TRANSMITTER UNIT LOCATED AT ORIFICE FLANGE
AIR SUPPLY

PNEUMATIC FLOW TRANSMISSION SYSTEM

The Brown New-Matic Remote Transmission System fills a definite need in industry. Instantly responsive—it provides the same high accuracy as electrical transmission for remote measurement and control of temperatures, pressures, flows and liquid levels in hazardous atmospheres where electrical transmission is not permissible in industrial processes.

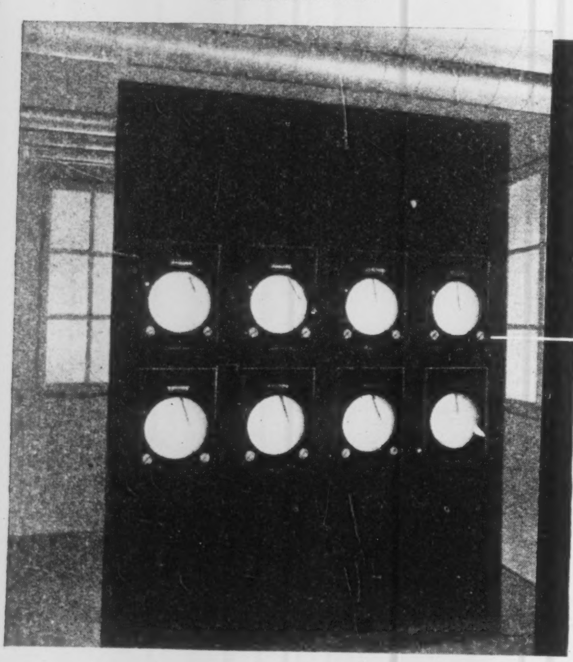
Not only does Brown New-Matic Remote Transmission assure a safe and reliable means of remote transmission of measurement and control, but it permits the use of indicating instruments at the transmitting end. It eliminates guesswork. Operators are provided with a direct, visual means of speeding up process operations with accuracy . . . no time lost waiting for a control room check-up on measurements.

All Brown New-Matic Systems are equipped with identical bellows in both the transmitting and receiving instruments. These bellows are factory "matched" to rigid specifications, insuring accurate calibration throughout the pressure range.

Rapid rate of response is obtained through the use of a non-bleed pilot. With tubing lengths as great as 1000 feet. The system is unaffected by ambient temperature changes or fluctuating air supply pressure.

The Brown New-Matic Remote Transmission system is safe, stable, accurate and powerful, and lends itself admirably to the growing demand for centralized recording and control.

Write for Catalog 5901. THE BROWN INSTRUMENT COMPANY, a *division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities. 117 Peter Street, Toronto, Canada: Wadsworth Road, Perivale, Middlesex, England, Nybrokajen 7, Stockholm, Sweden.



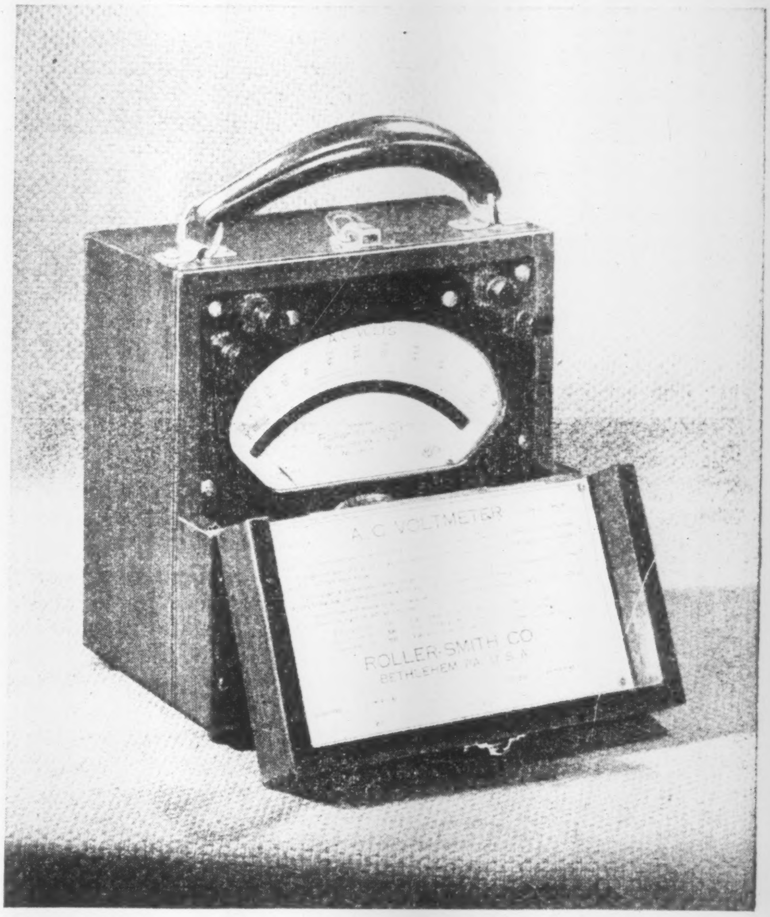
Recording controller mounted on centralized control panel in control room.

BROWN *NEW-MATIC* TRANSMISSION SYSTEM

FOR TEMPERATURES . . . PRESSURES . . . FLOWS . . . LIQUID LEVELS

A PORTABLE TESTING INSTRUMENT WITH NO PROJECTING PARTS

ROLLER-SMITH TYPE NP . . .



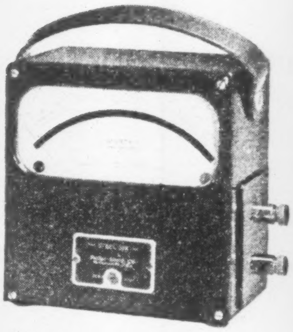
Roller-Smith Type NP Portable Testing Instruments are designed for general service where a highly accurate and extremely rugged instrument is required. The case is made in two parts: an outer walnut case and an inner two-piece metal case. This construction furnishes full magnetic shielding, protects the mechanism from external strains, and the movement from dust and moisture. The lid of the instrument is designed to completely cover the dial and all binding posts, so that when closed there are no projecting terminals or other parts. The window is of maximum area for high dial visibility; scale length is $5\frac{1}{4}$". Instruments are 8" square by $5\frac{1}{2}$" in depth and weigh approximately 7 pounds. Ratings cover a broad range of testing requirements.

Roller-Smith Type NP Instruments are supplied in single or multiple ranges for the measurement of direct current in milliamperes, amperes and volts, and alternating current in amperes, volts, watts, power factor and frequency. D-c instrument mechanisms are permanent magnet moving coil (d'Arsonval) type; a-c ammeters utilize a repulsion iron-vane mechanism and all other a-c instruments, an electro-dynamometer mechanism.

Catalog 4340 contains complete description and full information with prices. Write for a copy.

OTHER R-S INSTRUMENTS

Panel, switchboard and portable instruments of practically every standard size, shape, capacity, type and style are included in the R-S line of electrical instruments. Let us quote prices and deliveries on your instrument requirements.



"Steel-Six" Portable Ammeter. Scale length $5\frac{3}{16}$". Size 6" x 6" x 4". Accuracy ½ of 1%.

Type T-3.5" Miniature Panel Ammeter. American War Standard type conforming with AWS C39.2—1944.

ROLLER SMITH

Sales Representatives
In all Principal Cities

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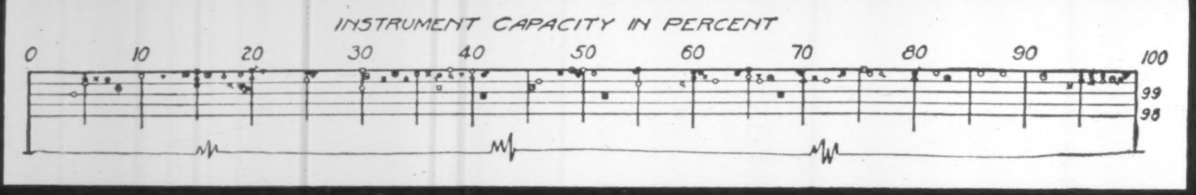
Canadian Plant: ROLLER-SMITH MARSLAND LTD., Kitchener, Ontario

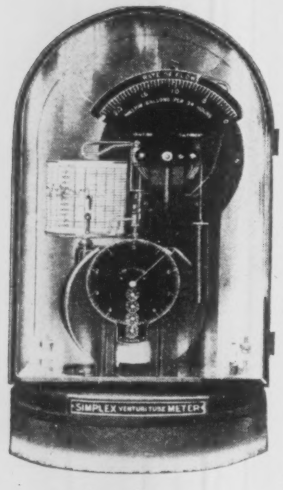
STANDARD AND PRECISION ELECTRICAL INSTRUMENTS • AIRCRAFT INSTRUMENTS • SWITCHGEAR
AIR AND OIL CIRCUIT BREAKERS • ROTARY SWITCHES • RELAYS • PRECISION BALANCES



Here is visual proof of the efficiency of Simplex MO Meters taken from Weighed Water and Volumetric tests.

The OVERALL ACCURACY of the SIMPLEX MO METER

AS SHOWN BY WEIGHED WATER and VOLUMETRIC TESTS



The matter of final concern to the user of a flow rate meter is the overall efficiency of the instrument — whether its purpose is to indicate, record, or totalize the flow.

The efficiency of sixteen Simplex MO Meters when tested in place by weighing scales and checked by the volume of standpipes is here illustrated. The data was taken at random from routine records of wide-range tests conducted by the laboratory of Simplex Valve & Meter Co. These accuracies speak for themselves.

In addition to its inherent accuracy, the Simplex MO Meter operates on a simple trouble-free principle which assures extreme sensitivity over the entire meter range. An applied differential head of 1/8 inch of water or less is sufficient to cause functional operation of this instrument. Any change in the rate of flow through a primary device is instantaneously and accurately recorded on the Simplex Meter Chart.

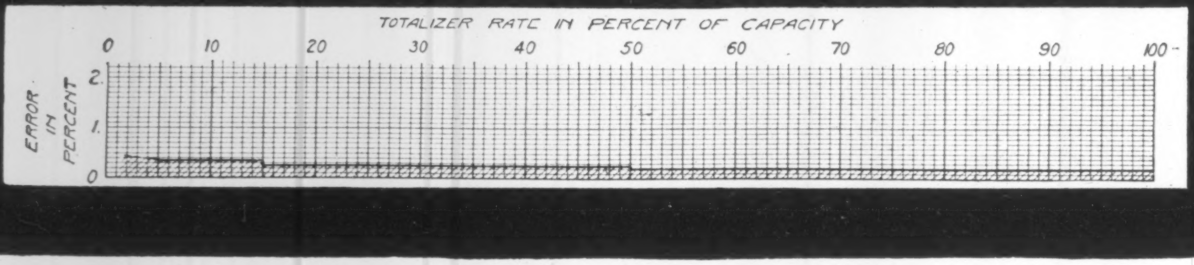
In the unique totalizer design, a frictionless vertical movement of the assembly occurs with flow changes. Constant speed revolution of a friction disc through the variable horizontal speed of a traction roller integrates the rate of flow. The result is highly dependable, accurate totalization of flows over the entire range of the instrument.

Investigate the exceptional values of the Simplex MO Meter. Write today for Bulletin 300.

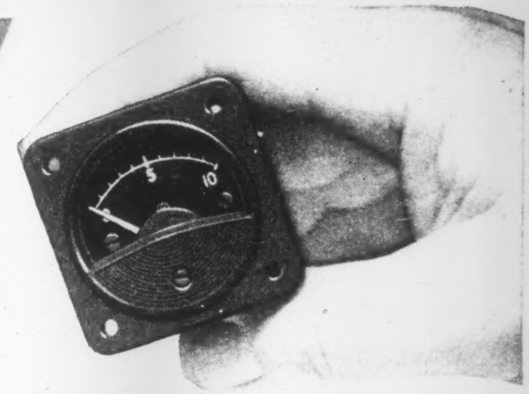
BLUE PRINT NOW!

SIMPLEX VALVE & METER CO.
6786 UPLAND STREET, PHILA. 42, PA.

An error curve showing totalizer rate in percent of capacity against actual weighed water.



Here They Are!



25
50
0
D.C. VOLTS

The New 1½ INCH

G-E PANEL INSTRUMENTS

To meet the need for compactness, especially in electronic and communication devices for combat, they have a body diameter of only 1½ inches, are less than 1 inch deep, and weigh only 3 ounces. They are accurate to within ±2 per cent.

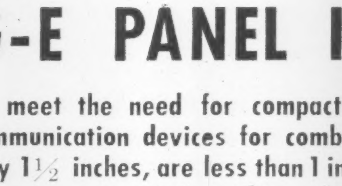
These instruments are of the internal-pivot construction, and in addition to small size and light weight, they have all the other desirable features associated with this unique G-E design.

Because of its high torque and large-radius pivots, the element (which is common to both instruments) is well able to withstand vibration. High torque combined with a lightweight moving element results in fast response. Good damping makes for ease and accuracy of reading. Large clearances help to insure reliable operation.

All these features add up to a high factor of merit and all-round excellent performance.

For advance information, ask the nearest G-E office for Booklet GEA-4380, or write to General Electric Co., Schenectady 5, N.Y.

THEY'RE G-E INTERNAL-PIVOT INSTRUMENTS



One advantage of the internal-pivot design is compactness. Armature, core, control springs, pivots, jewels, balance weights, and pointer form a single, self-contained unit, all parts of which are supported by a cast-comol magnet.

GENERAL ELECTRIC

602-83-6200

WATERTIGHT

TYPES DN-1, -2, -3

(Left hand, above)

- For applications where equipment may be used in an extremely humid atmosphere, exposed to rain, or accidentally submerged in water. Available for direct-current (DN-1), radio-frequency (DN-2), and audio-frequency (DN-3) service.

CONVENTIONAL

TYPES DN-4, -5, -6

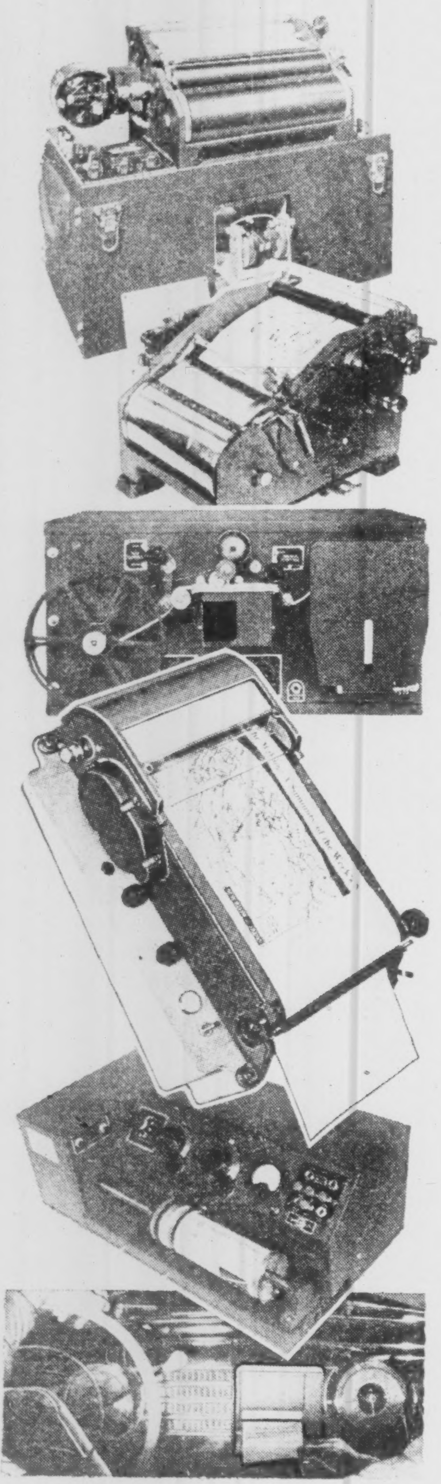
(Right hand, above)

- For use on aircraft and on communications or electronic devices where the instrument is protected. Available for direct-current (DN-4), radio-frequency (DN-5), and audio-frequency (DN-6) service.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

Buy all the Bonds you can—*and keep all you buy*

ALDEN



for Graphic Recording of any kind

OUR YEARS OF EXPERIENCE, and cumulative skills, in the Designing and production of RADIO COMPONENTS, are now being used in making equipment which covers **the entire field of FACSIMILE.**

Actual service, as found in war and communication work under all conditions, has given a PRACTICAL quality to our equipment which, under ordinary conditions, would not have been obtained in years of engineering with limited application.

ALDEN PRODUCTS COMPANY is manufacturing practically ALL TYPES AND SIZES of facsimile and impulse recording equipment—using all the varied recording mediums: Photographic Paper, Film, Electrolytic Paper, Teledeltos, and Ink.

ALFAX IMPULSE RECORDING PAPER

●

By "COVERING THE ENTIRE FIELD," we mean . . .

1• Some of our equipment has been used for the transmitting and receiving of photographic pictures of reasonably high resolution (such as the war pictures now appearing in the news).

2• Continuous Recorders—of the type whose value has been proven on National and International news service circuits—are now on their way to the Orient, to be used for the receiving of the so-called "picture" languages.

3• Also, through the use of ALFAX (the first high-speed black and white permanent recording paper), HIGH-SPEED Signal Analysis Equipment has been made possible for various laboratories and Government Departments. Other equipments have employed Teledeltos Paper for message work and other purposes.

4• The ability of ALFAX Paper and ALDEN Machines to record impulses *as they occur,* without the inertia problems of many previous methods, has made possible other recorders at various speeds (including slow). They will record a whole day's history of related phenomena, with time indicated, and often—with self-calibrated linear reference marks for ready interpretation.

5• ALDEN tape Recorders (recording medium, Ink)—have been designed to operate with a minimum of trouble and adjustments, and have PROVED MOST SATISFACTORY in day-to-day service.

ALDEN PRODUCTS COMPANY

117 North Main Street
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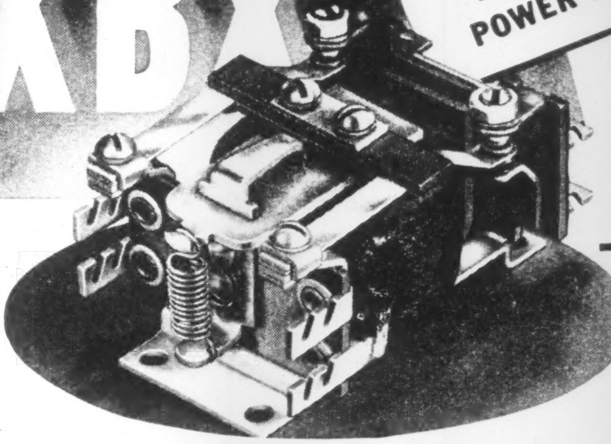
10XBX

DELIVERS A LOT OF POWER FOR ITS SIZE

COVERS A WIDE RANGE OF APPLICATIONS

HIGHLY RESISTANT TO SHOCK AND VIBRATION



...A GOOD RELAY TO KNOW!

If any Relay type ever deserved the name "All-Purpose" it is Type 10XBX of the Struthers-Dunn 10-frame series. While new and special types come and go, this popular 2P. D.T. relay continues in heavy favor with leading users to whom its extreme versatility on a wide range of applications holds strong appeal. From audio frequency circuits to motor control circuits; from naval battle announcing stations where shock resistance is important, to aircraft use where vibration is a big factor, 10XBX relays are performing competently and well.

These relays are light, small, and sturdy. Highly electrically efficient, they deliver a lot of power for their size. Contact pressures up to 50 grams are available. Bakelite insulation is supplied for power circuit applications, and ceramic insulation for radio-frequency use. A-C coils to 115v, 60 cycles; or d-c coils to 115v are available. Contacts may be in any desired combination up to and including 3 pole, double throw. All 10XBX relays withstand 10G vibration and are highly resistant to shock. Other relays of the 10-frame series are available in either single or three pole contact arrangements.

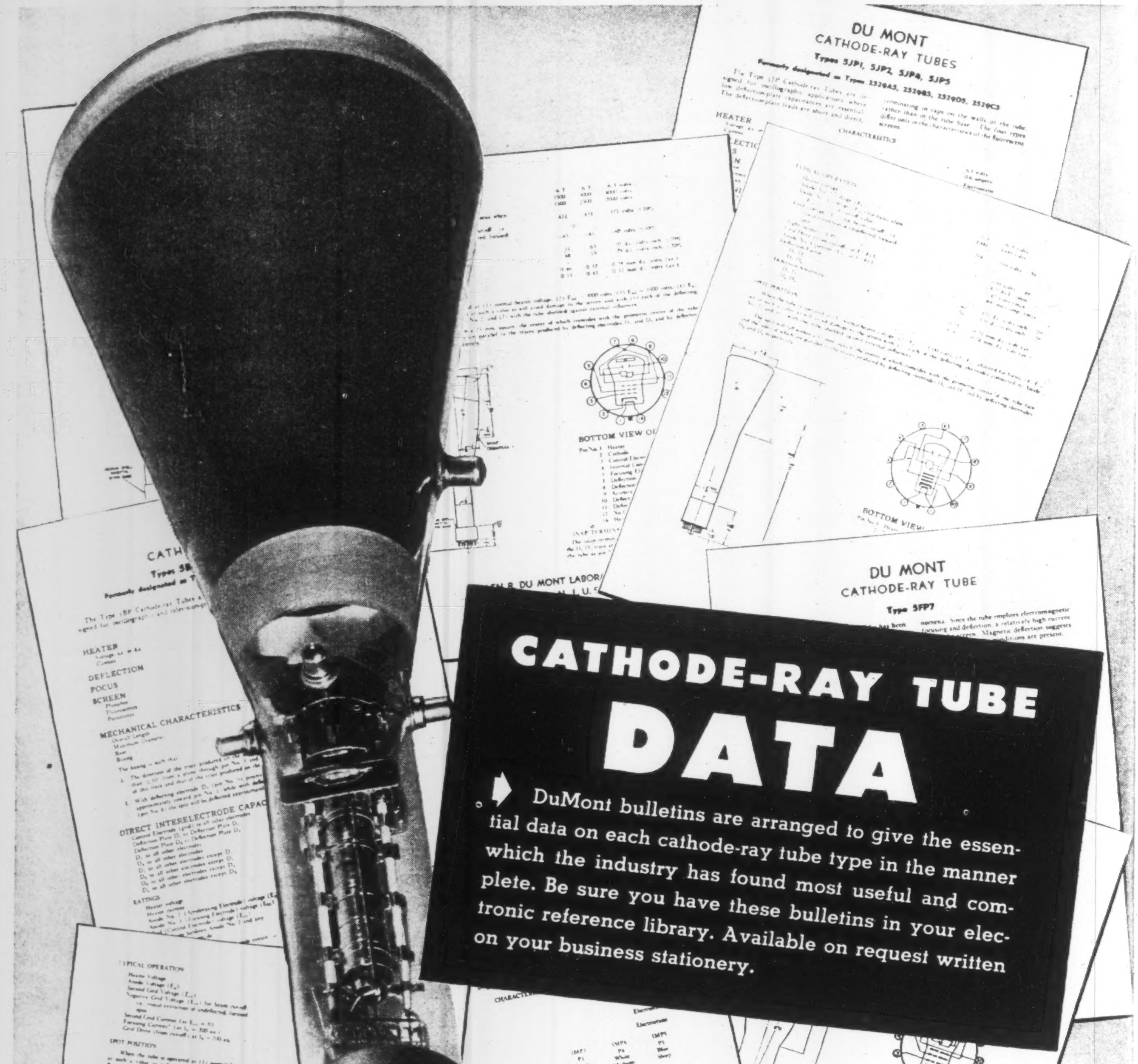
STRUTHERS-DUNN, Inc., 1321 ARCH ST., PHILADELPHIA 7, PA.

WRITE *for the big Struthers-Dunn 48-page Catalog and Relay Engineering Data Book.*

STRUTHERS-DUNN

5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO • WASHINGTON


DU MONT
CATHODE-RAY TUBES
Types 5JP1, 5JP2, 5JP4, 5JP5
DU MONT
CATHODE-RAY TUBE
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BOTTOM VIEW OF BASE
ALLEN B. DU MONT LABORATORIES, INC.
PASSAIC, N. J., U. S. A.

CATHODE-RAY TUBE DATA

➧ DuMont bulletins are arranged to give the essential data on each cathode-ray tube type in the manner which the industry has found most useful and complete. Be sure you have these bulletins in your electronic reference library. Available on request written on your business stationery.

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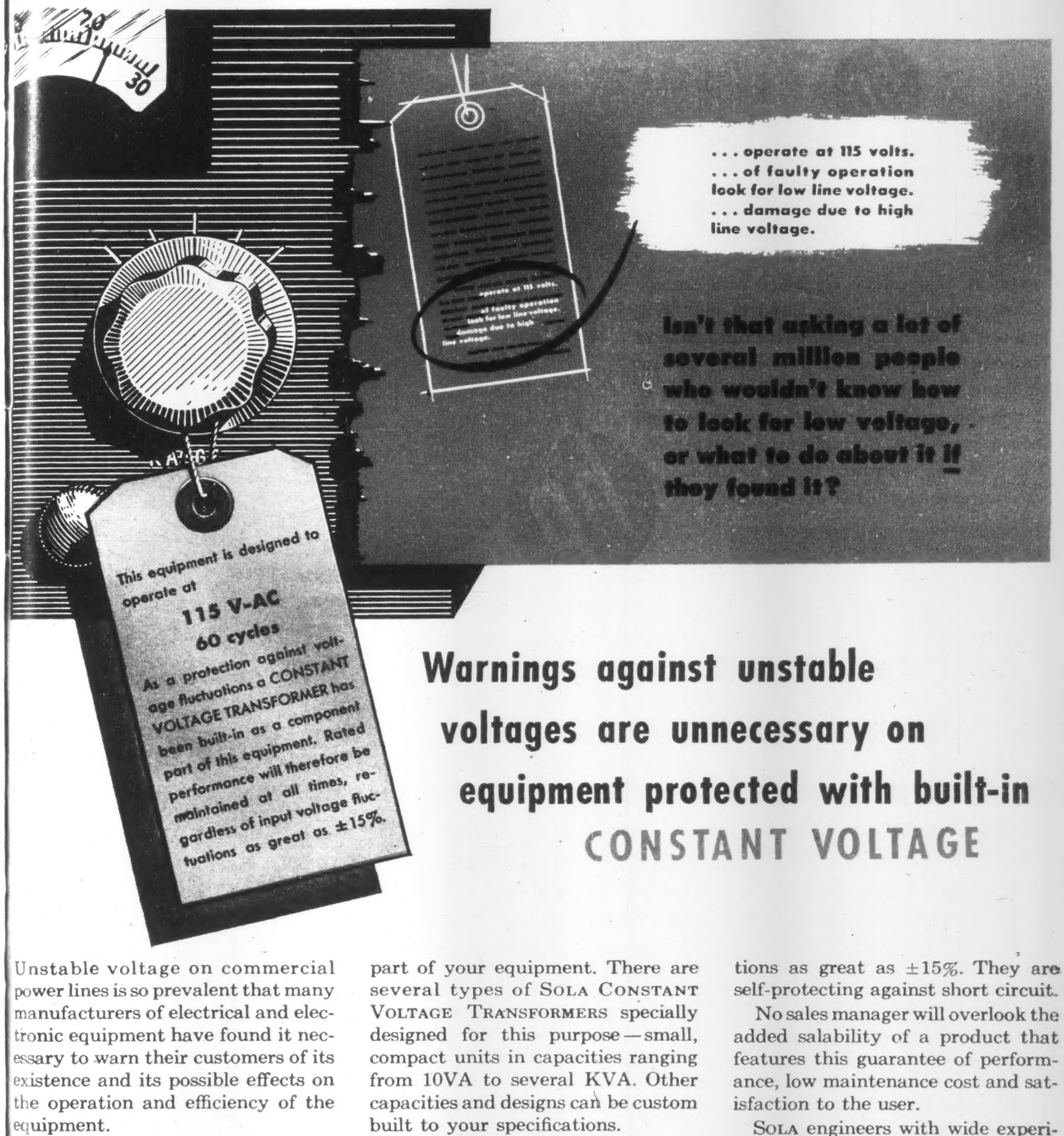
DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK


20
30
. . . operate at 115 volts.
. . . of faulty operation look for low line voltage.
. . . damage due to high line voltage.
Isn't that asking a lot of several million people who wouldn't know how to look for low voltage, or what to do about it *if* they found it?
This equipment is designed to operate at
115 V-AC
60 cycles
As a protection against voltage fluctuations a CONSTANT VOLTAGE TRANSFORMER has been built-in as a component part of this equipment. Rated performance will therefore be maintained at all times, regardless of input voltage fluctuations as great as ±15%.

Warnings against unstable voltages are unnecessary on equipment protected with built-in CONSTANT VOLTAGE

Unstable voltage on commercial power lines is so prevalent that many manufacturers of electrical and electronic equipment have found it necessary to warn their customers of its existence and its possible effects on the operation and efficiency of the equipment.

There is an easy and inexpensive solution to this important problem —specify a Sola Constant Voltage Transformer as a component part of your equipment. There are several types of Sola Constant Voltage Transformers specially designed for this purpose—small, compact units in capacities ranging from 10VA to several KVA. Other capacities and designs can be custom built to your specifications.

Once installed in your equipment they require no pampering or supervision. They are fully automatic, instantly correcting voltage fluctuations as great as ±15%. They are self-protecting against short circuit.

No sales manager will overlook the added salability of a product that features this guarantee of performance, low maintenance cost and satisfaction to the user.

Sola engineers with wide experience in the application of the Sola Constant Voltage principle are available for consultation on details of design specifications.

SOLA

Constant Voltage Transformers

To Design Engineers:

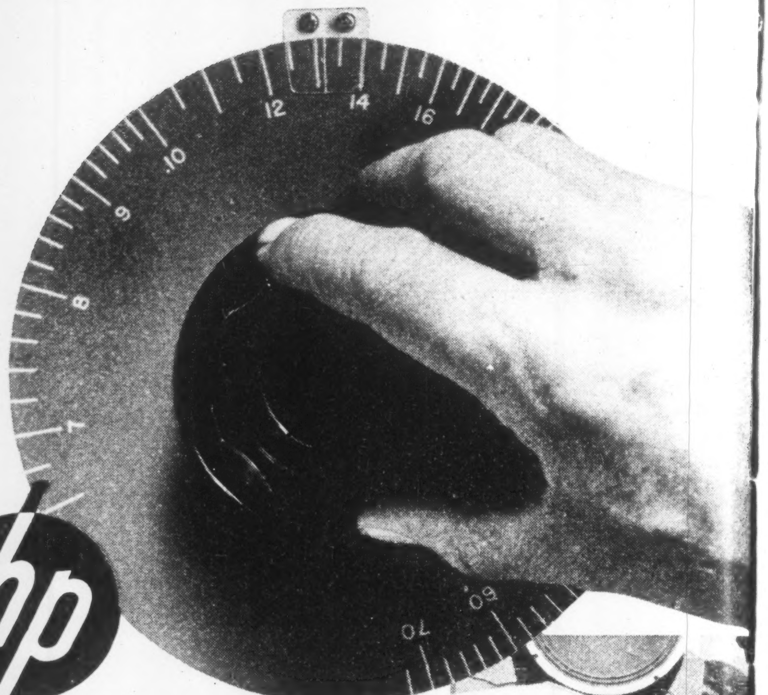
Complete, new hand-book of Constant Voltage Transformers available on request.

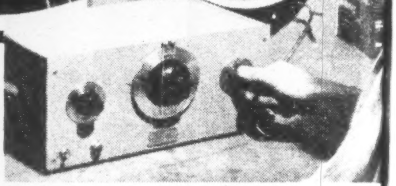
Ask for Bulletin GCV-102

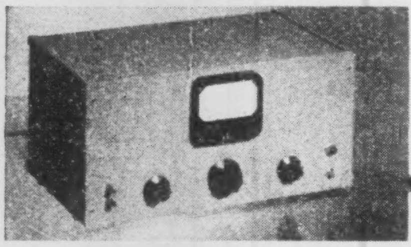
Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago 14, Ill.**

INSTRUMENTS COVER A WIDE RANGE OF USES

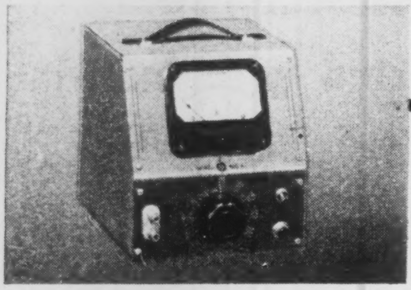
Simplicity of operation combined with extreme accuracy makes for greater speed in measuring and testing AF apparatus. These fundamental characteristics are basically what makes *-hp-* Instruments outstanding in the field. The variety of instruments available and the range of tests and measurements they accomplish is comprehensive. The following is a partial listing of standard *-hp-* instruments available at this time:





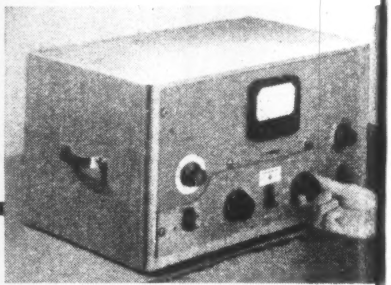


Audio frequency oscillators of the resistance-tuned type. Excellent frequency stability and freedom from wave form distortion. Model 200B Resistance-Tuned Oscillator illustrated.



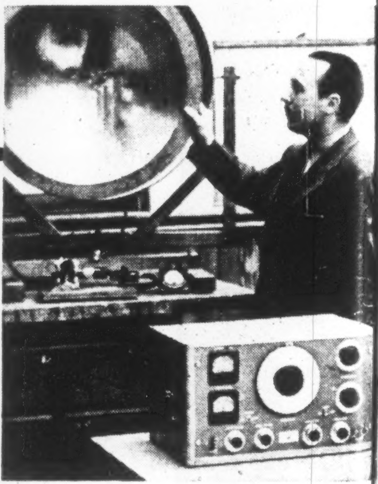
Instruments for measuring frequency including secondary frequency standard and electronic frequency meters. Model 500A Electronic frequency Meter illustrated.

Instruments for measuring voltage in the audio and high frequency range. Model 400A Vacuum Tube Voltmeter illustrated.



Instruments for making over all measurements on audio equipment including total harmonic distortion, frequency response, and hum level. Model 325B Distortion Analyser illustrated.

Harmonic wave analysers with many new features including variable band width. Model 300A Wave Analyser illustrated.



Audio signal generators providing standardized voltage throughout the audio frequency range. Model 250AG Audio Signal Generator illustrated.

If you have a special problem *-hp-* Engineers will gladly cooperate without cost or obligation. Ask for Catalog number 17A and enter your name for regular receipt of technical bulletin.

HEWLETT - PACKARD COMPANY

Box 876C • Station A • Palo Alto, California

876

2,000 MILES—AND A PERFECT LANDFALL

SOUPY WEATHER and cross winds for most of the passage. Yet they hopped 2,000 miles across the pond and fetched Mog Light dead on the nose! That's *navigating;* and precision instruments made of VINYLITE plastic rigid sheets help airmen do it consistently. Such instruments keep their accuracy under a wide temperature range and varying atmospheric conditions—they're dimensionally stable because that's an outstanding quality of VINYLITE plastic rigid sheets. This material is fast becoming a first choice for the drafting, measuring, and computing devices used by fliers, artillerymen, and engineers on every front.

But to instrument makers, VINYLITE plastic rigid sheets bring far more than dimensional stability. They take and hold close-register, multi-color printing. They're light weight, yet have high tensile and impact strength. They're resistant to alcohols, oils, most chemicals, oxidation, and abrasion.

VINYLITE plastic sheets are available in various thicknesses; either matte, press-polished, or calender-finished. There's a choice of colors, too, in transparent, translucent, or opaque.

Write Department 35 for literature describing VINYLITE plastic rigid sheets and recommended techniques for fabrication.

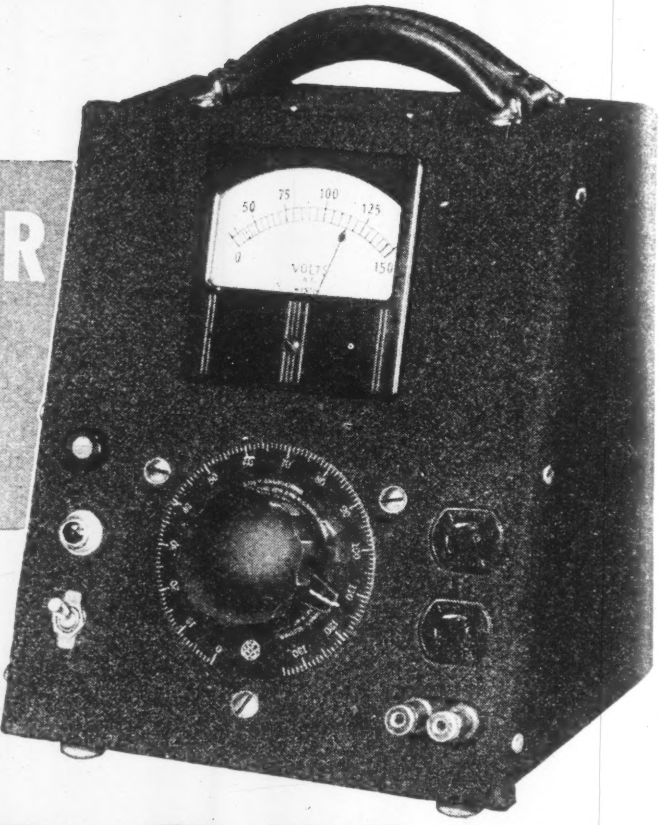
BAKELITE CORPORATION
Unit of
Union Carbide and Carbon Corporation
UCC
30 EAST 42ND ST., NEW YORK 17, N. Y.

Vinylite Plastics

TRADE-MARK

TO SET YOUR VOLTAGE

use a POWERSTAT



VOLTBOX

..for..

RESEARCH

PRODUCT-TESTING

HEAT RISE

LIFE CYCLE

QUALITY-CONTROL

etc.

In presenting this new and unique instrument, SECO offers a portable source of variable a-c voltage for the laboratory, assembly line, or maintenance shop. There is no bother or delay in collecting and setting-up separate instruments. Included in the light-weight and compact VOLTBOX are all the essentials and more. Besides a POWERSTAT variable transformer to obtain the required voltage and a 1% voltmeter to accurately set the output — other features incorporated are an "on-off" switch, dial light, output receptacles, binding posts, and an input cord and plug.

By connecting the VOLTBOX shown above to a convenient 115 volt outlet, an output variable from 0-135 volts is available. Its current rating is 7.5 amperes. Other types are manufactured for 230 volt operation.

We invite your inquiries.

Send for Bulletins 149SI and 163SI

SUPERIOR ELECTRIC COMPANY

423 LAUREL STREET, BRISTOL, CONNECTICUT

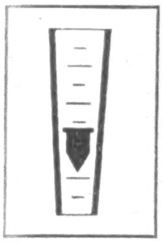
A quiet advertisement for a noise-weary World

—the Rotameter and its advantages to you for flow rate measurement and control

With all the noise in the World today, perhaps you will appreciate advertisements of a more quiet sort. So we are taking this simple way of telling you about our product.

We make rotameters for flow rate measurement and control, and we believe it is important that you know about them because they offer advantages which you cannot obtain in any other flow rate measuring device. First, let us describe the principle of the rotameter.

The Principle of the Rotameter



The rotameter is an "area-type" meter in which the variation in area is obtained by means of a vertical *tapered* tube with the smallest diameter at the bottom. A weight of fixed diameter (called the "float") moves freely within this tapered tube and hence the area between the float and tube *increases* as the float rises. This area then becomes a measure of the flow and for every flow rate there is a fixed position of the float in the tube. Therefore, the rotameter can be accurately calibrated to read directly in flow rate. This method of flow measurement gives advantages of great importance.

The Advantages of the Rotameter

Succinctly stated, the main advantages of our rotameter are as follows:

(1) Since the metering tube is usually transparent, the main metering elements (float and tube) and the fluid being metered are *clearly visible.* High accuracy may be maintained because dirt accumulations are immediately perceived and because a secondary remote reading instrument, when used, may be quickly checked against the primary metering element, the rotameter.

(2) A wide flow range may be obtained in one rotameter. A ratio of 20 to 1 from maximum to minimum flow is easily reached if necessary.

(3) Since area variation is measured (rather than head), the calibration curve of the rotameter is practically a straight line so that a direct reading scale with evenly spaced divisions is obtained. There is no compression of the divisions at low flows, so the same high metering accuracy is gained *throughout the flow range.*

(4) Because the area between the float and tube increases when the flow rises, the pressure drop across the float is low and *constant.* Pumping costs are reduced and low initial head may be tolerated by using an oversize meter with a light float.

(5) Our patented Stabl-Vis rotameter compensates for normal variations in viscosity and density so that viscous oils and chemicals, such as concentrated sulphuric acid, may be measured accurately in spite of wide temperature changes.

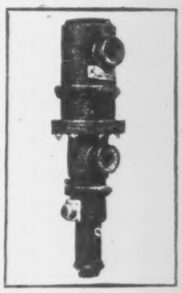
(6) The metering float travels a distance of at least 5 inches, and meters are obtainable with float travel as long as 24 inches. Hence, by shortening the flow range and lengthening the float travel, higher accuracies may be obtained with the rotameter than with any other flow rate measuring device.

(7) The float moves freely in the metering tube so there is no friction or hysteresis. Therefore, the rotameter reaches the Instrument Engineer's ideal goal of high accuracy, *consistently maintained* during years of service.

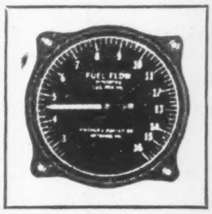
(8) Due to its simplicity, the rotameter is readily made corrosion proof and, therefore, may be used to measure flows of gases, liquids and slurries that no other meter will handle with continuous success.

(9) Also, due to its simplicity, the rotameter is easy to install and reasonable to maintain.

The Scope of Fischer & Porter Rotameters



We originated the precision-bore tapered rotameter tube of boro-silicate glass, and have designed and built a full line of rotameters to solve the varied flow rate problems of Industry. We can measure liquid flows from 0.15 cubic centimeters per minute up to 14,000 gallons per minute, and gaseous flows from 3 cubic centimeters per minute up to 16,000 cubic feet per minute. Temperatures to 750° F. and pressures to 10,000 p.s.i. can be provided for in our equipment. Flow indication, flow recording, flow totalization and automatic flow control are all available to you in designs which have been proved by many field installations to be practical, accurate and dividend-paying meters.



A steady stream of basic improvements in the rotameter have come from our research laboratories. A most recent worthwhile development has been a marked betterment in the electrical inductance-bridge method of telemetering the position of the rotameter float to a remote recording or controlling instrument. This method in the past has been somewhat discredited by Instrument Engineers because it was subject to errors from temperature and voltage variations, and because it lacked power. Because of the great simplicity of the inductance-bridge principle, we decided not to accept this dictum, so we went to work to overcome its weaknesses. Today we can guarantee that our new circuit is not affected by wide variations in either temperature or voltage, and furthermore it has *three times* the power of any previous comparable instrument, so that the pen now positions with speed, positiveness and accuracy.

One of our most important recent product announcements for aviation has been a remote-reading flight meter for gasoline or oil. This instrument has a new electric circuit that is free of friction and hysteresis. It is also the only flight meter that compensates for viscosity and density variations in the fluid being metered. It offers high accuracy in flow rate measurement for post-war planes.

How to obtain "A New Era in Flow Rate Measurement"

A NEW ERA
in
FLOW RATE
MEASUREMENT

FISCHER & PORTER COMPANY
HATBORO • PENNSYLVANIA

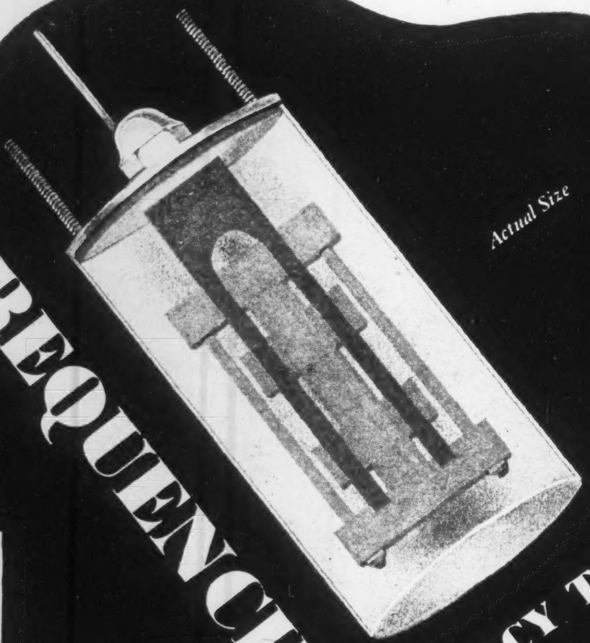
We have prepared an interesting bulletin entitled, "A New Era in Flow Rate Measurement," which expands the above material into a profusely illustrated, semi-humorous and instructive manual for those who have flow rate control problems and who would, therefore, like to know more about our rotameters. If you will write to us, we will gladly send you a free copy without any obligation. If, in the same letter, you can outline one of your most important flow rate problems, we'll tackle it gladly and try to come up with a good answer for you.

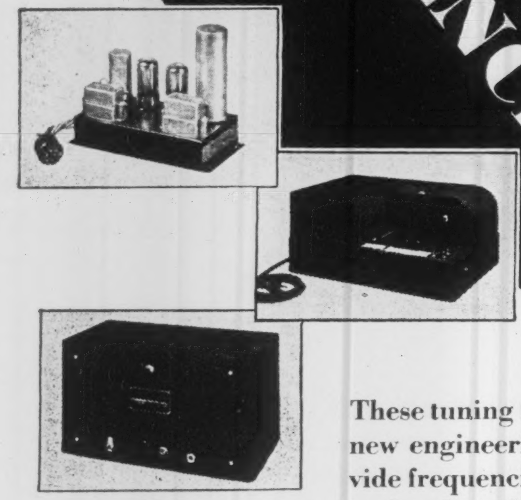
FISCHER & PORTER COMPANY
2304 COUNTY LINE ROAD • HATBORO • PA.

Fischer & Porter Company has pioneered EVERY basic rotameter improvement!

LOW FREQUENCIES

ACCURACY TO 1/1,000th of 1%





TOP
FREQUENCY STANDARD
(60 cycle) for use with
external power supply

CENTER
CHRONOGRAPH
Records time intervals
with resolution to .001 second

BOTTOM
FREQUENCY STANDARD
(120 cycles) with
self-contained power supply

These tuning forks which include new engineering principles, provide frequencies from 120 to 1,000 cycles directly with an unqualified guarantee of accuracy to 1 part in 100,000 over a wide temperature range. (Better than 1 second in 24 hours). Closer tolerances are obtainable on special order.

These tuning fork assemblies are available only in single or multi-frequency instruments of our own manufacture which are designed to test, measure or control other precision equipment by mechanical, electrical accoustical or optical means.

The dependability of these frequency standards is being demonstrated for myriad purposes in all climates and under all working conditions.

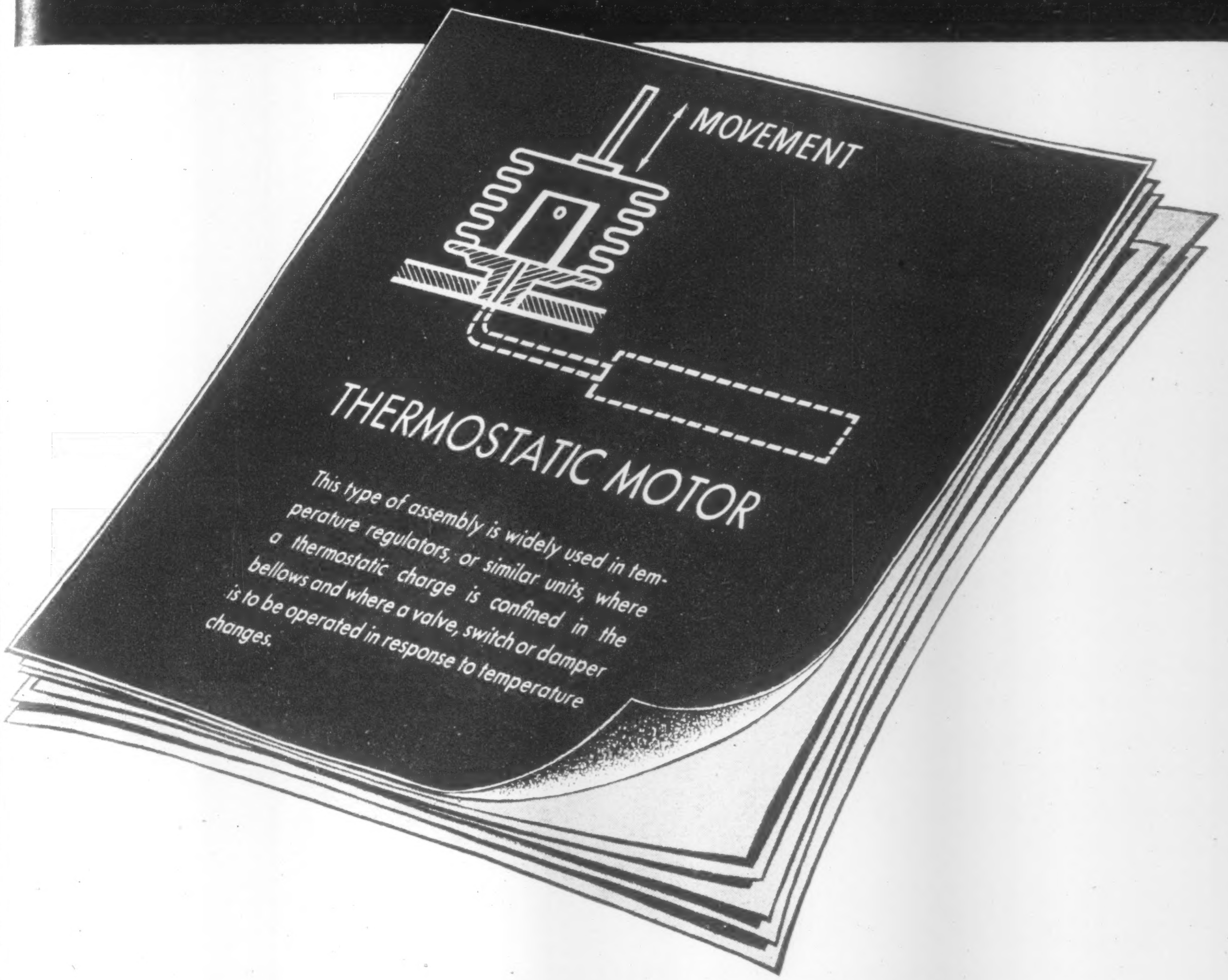
If you have need for low frequency standards of exceptional accuracy, your inquiries are invited.

American Time Products, Inc.

580 Fifth Ave. **New York, N. Y.**

Dist. of Western Electric & Watch Master Watch-rate Recorders

FROM SIMPLE BASIC APPLICATIONS...



This type of assembly is widely used in temperature regulators, or similar units, where a thermostatic charge is confined in the bellows and where a valve, switch or damper is to be operated in response to temperature changes.

Come Various Types of Assemblies

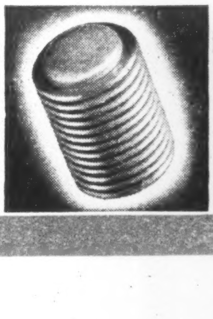
It would be difficult to think of a control device as simple as a bellows, or one as effective and efficient.

Temperatures and pressures are translated into direct motor action; expansion is absorbed; motion is transmitted; rotating shafts sealed, all by means of bellows and bellows assemblies. In fact, correctly designed and engineered bellows offer simple solutions to many seemingly complicated problems.

Bridgeport Bellows are unit-constructed, with no seams or solder. They are built to serve indefinitely.

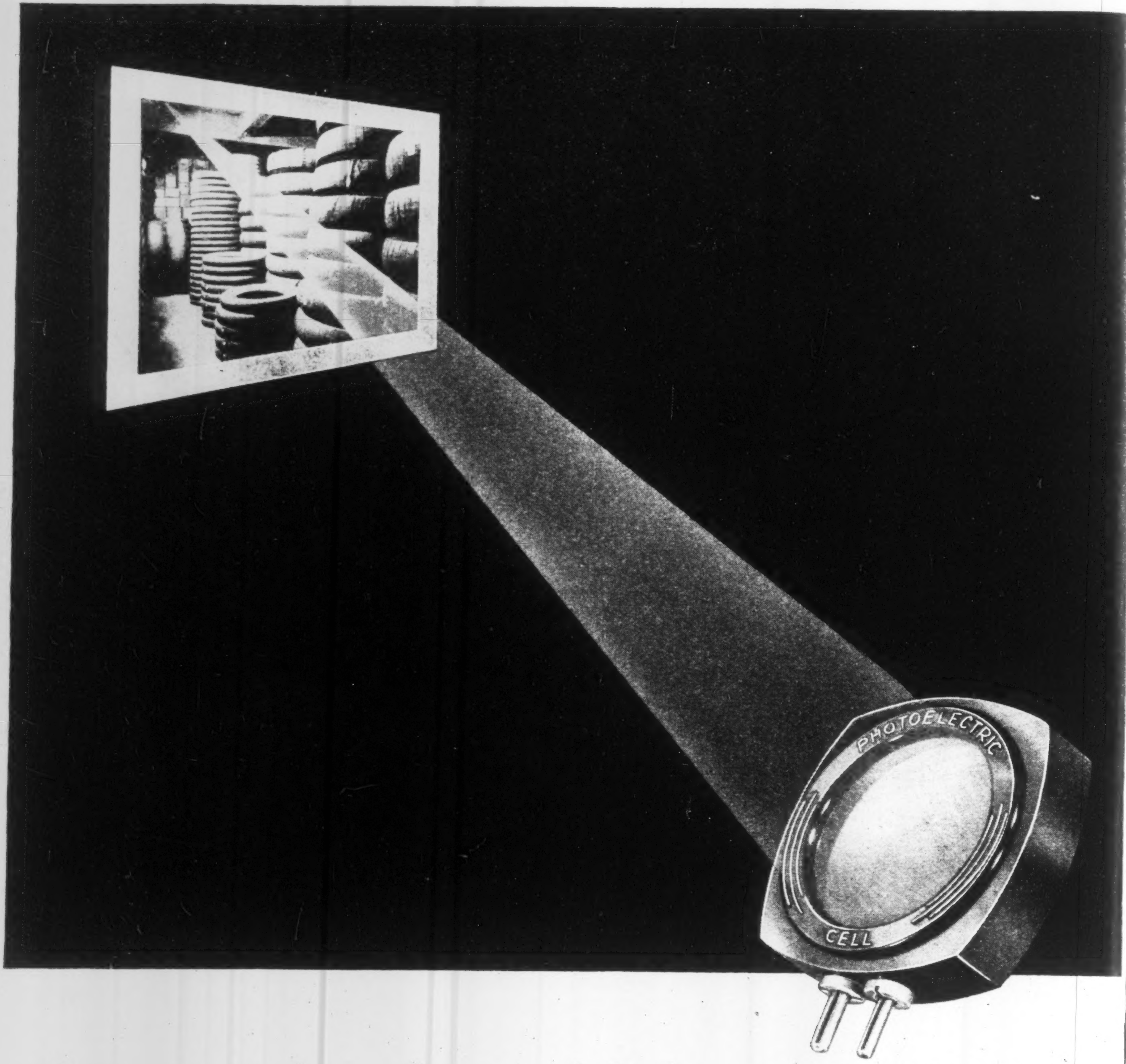
Whatever your problem—if it conceivably concerns bellows, we would like to discuss it with you. Our engineering department is at your service; our manufacturing facilities, complete and ready to meet your schedules.

Write for new catalog GE-100.



Bellows Assemblies . . . Bellows . . . Bellows Devices

BRIDGEPORT THERMOSTAT
COMPANY, INCORPORATED—BRIDGEPORT 1, CONN.



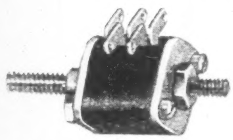
How to make a beam of light scream "FIRE!"

Fire protection by means of Luxtron* photocells employs a steady source of light. When blocked by smoke or deflected by smoke particles, it decreases or increases the flow of current from the cell and activates the entire protection system. . . . By using Luxtron photocells, light can be converted to electric energy, sufficient to operate meters and meter relays without costly bulky amplifiers, and with assurance of long life under strenuous conditions.

Photocells today are doing everything from calmly watching batches of textiles for perfect color match . . . to sitting undismayed on roaring machinery, stopping it when trouble is in sight. To learn if photocells can help you, write Bradley Laboratories.

*T. M. REG. U. S. PAT. OFF.

Another Bradley Development



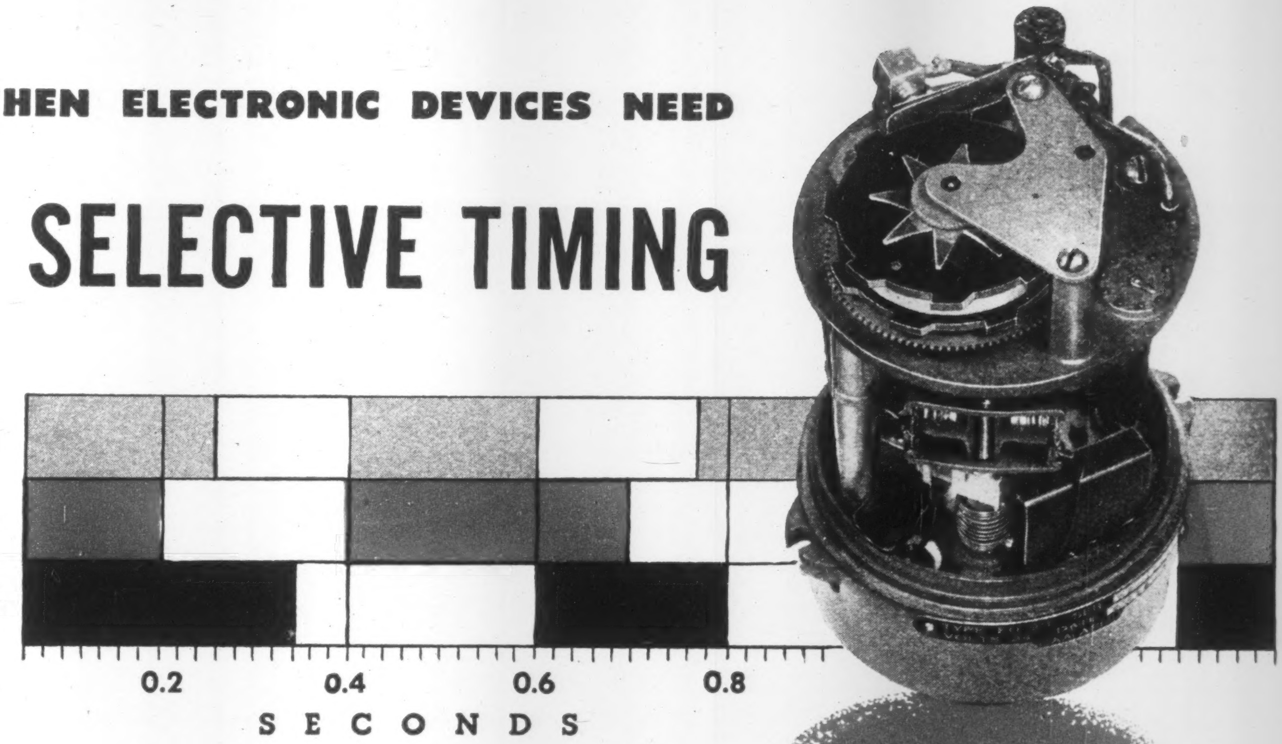
This is one of a unique group of "Coprox" (copper oxide) rectifiers developed and manufactured by Bradley with the same understanding of electrical circuits that goes into Luxtron photocells. Write for illustrated "Coprox" bulletin.

PHOTOCELLS—MASTERS OF LIGHT **BRADLEY** **MASTER OF PHOTOCELLS**

BRADLEY LABORATORIES, INC., 82 MEADOW STREET, NEW HAVEN 10, CONNECTICUT

WHEN ELECTRONIC DEVICES NEED

SELECTIVE TIMING



Selective timing of two or more circuits to hundredths of a second is dependably accomplished with the W&T Constant Speed Motor Mechanism.

With a current input of only 0.003 milliamperes, the motor delivers 1800 gram inches per minute (a feature of especial importance in battery powered systems). It operates at a constant speed, regardless of voltage changes as great as ±20%.

Compact and self-contained, the mechanism is easily built into electronic control devices.

Write for illustrated technical bulletin

THE W&T CONSTANT SPEED MOTOR MECHANISM

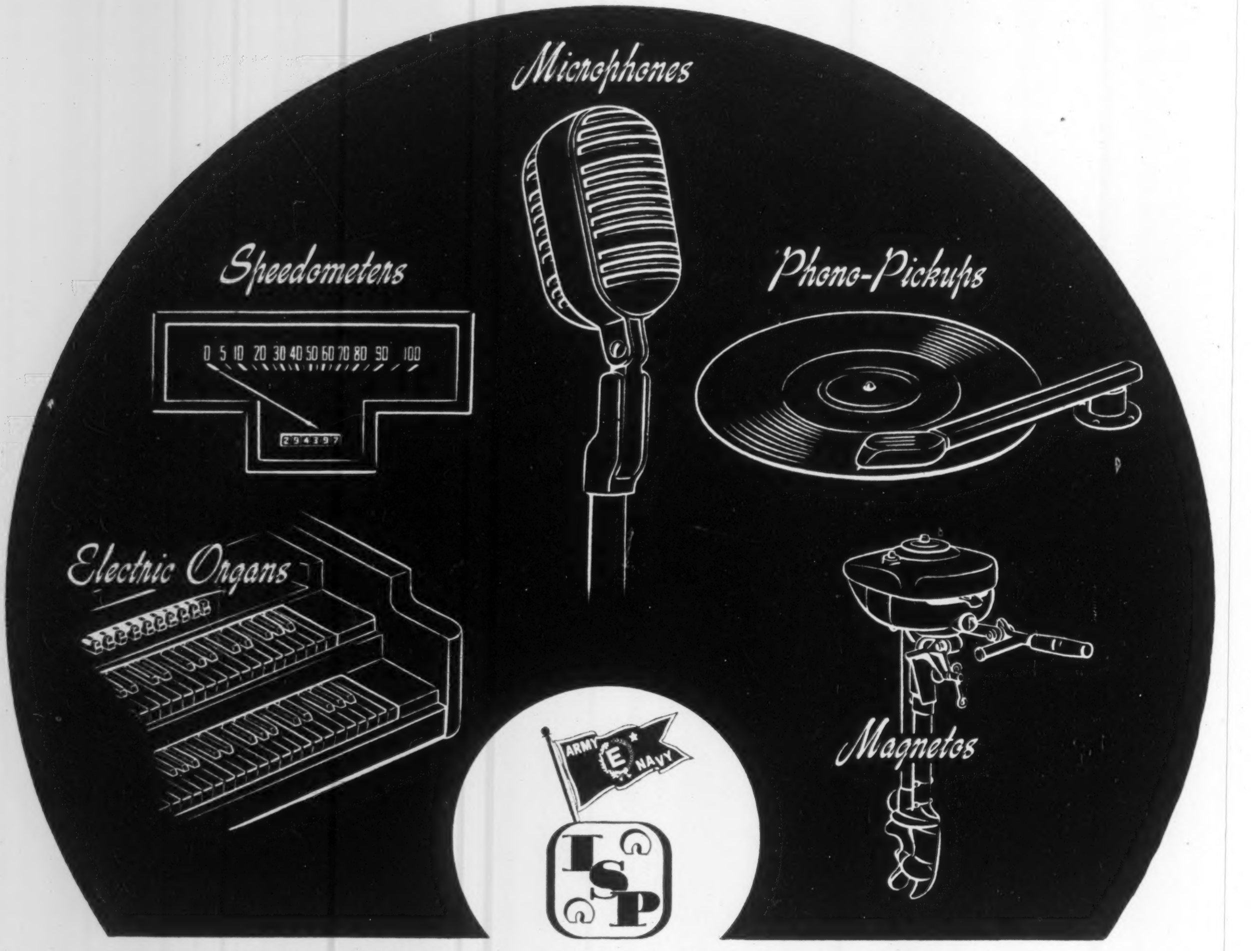
A-44

WALLACE & TIERNAN PRODUCTS, INC.

ARMY E NAVY

BELLEVILLE 9 NEW JERSEY

PERMANENT MAGNETS MAY DO IT BETTER



(This is the first of four advertisements discussing the major functions of permanent magnets)

ELECTRIC CURRENT from MECHANICAL ENERGY through PERMANENT MAGNETS

The ability to create an electric current through the agency of a permanent magnet suggests to the engineer or product designer a wide range of useful applications.

Permanent magnets are able to transform mechanical into electrical energy in two ways—

1. *By producing a magnetic field through which an electrical conductor is moved mechanically—as in the case of generators, magnetos and velocity or dynamic microphones.*

2. *By acting as a polarizing agent, where reluctanc to the magnetic circuit is varied by mechanical means; for example—the phonograph pick-up an inductor type magnetos and generators.*

This characteristic of the permanent magnet permit its use for the generation of electricity for actual power uses, or to produce devices for the control, detection and measurement of many materials.

Backed by 34 years of experience as the larges exclusive manufacturers of permanent magnets, our engineers will gladly consult with you on problems where the use of permanent magnets may do the job better. Write for free copy of technical booklet: "*Permanent Magnets Have Four Major Jobs*".

★ THE INDIANA STEEL PRODUCTS COMPANY ★

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

Specialists in Permanent Magnets Since 1910

COPYRIGHT 1945, THE INDIANA STEEL PRODUCTS COMPANY

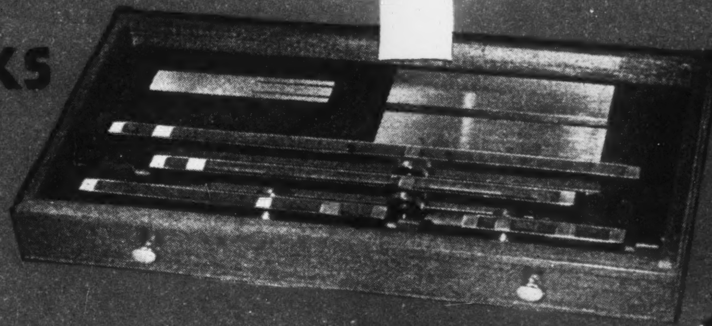
It's simple arithmetic

DoAll Gages
KEEP CASE CLEAN

DoALL
GAGE
BLOCKS

+

DoALL
GAGE
ACCESSORIES



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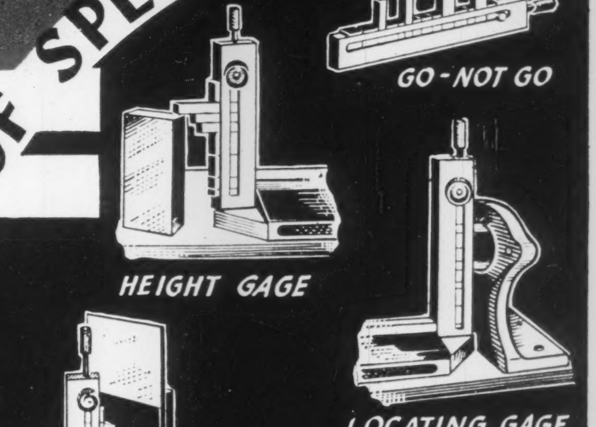
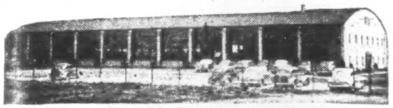
ALL KINDS OF SPECIAL GAGES


GO-NOT GO
HEIGHT GAGE
LOCATING GAGE
SCRIBER
SNAP GAGE



Where DoALL Gages Are Made

QUALITY CONTROL

Write for new
QUALITY CONTROL BOOK

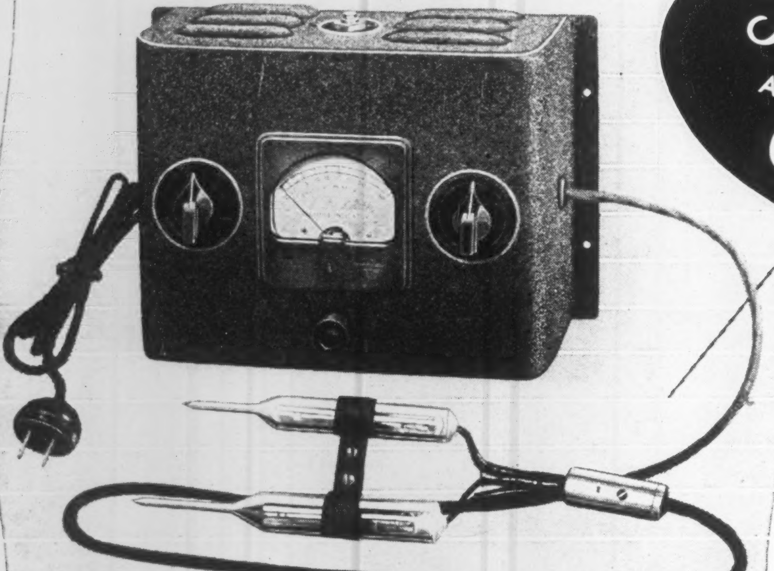
DoALL

INDUSTRY'S NEW SET OF TOOLS

CONTINENTAL MACHINES, INC.
1368 S. Washington Ave. • Minneapolis 4, Minn.

Sales & Service Offices: Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, El Paso, Erie, Grand Rapids, Hartford, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, Minneapolis, New York, Orlando, Philadelphia, Pittsburgh, Providence, Reading, Rochester, Rockford, St. Louis, San Francisco, Seattle, Statesville, Syracuse, Toledo, Tulsa.

long needed–now ready



Tru/Vac
A-C OPERATED
GAUGE

for critical vacuum measurements . . . operating from any 110–20 V. A C line

This latest development in a Pirani-type instrument for vacuum measurement is an important step forward in providing the convenience of AC operation from any 110-120 volt power line.

Model 18 Tru-Vac Gauge is scaled to read pressures of a vacuum system from .25 to 250 microns and is accurate to plus or minus 2% throughout the scale, with constant voltage input.

Gives continuous readings . . . unaffected by changes in barometric pressure . . . Adjustment may be made to provide for line voltage fluctuations.

Meter and controls contained in compact metal case measuring only 8 x 6 x 3½ in. Controls can be mounted at distance from actual processing operations. Tru-Vac Gauge is extremely useful in wide range of industries making products requiring constant or intermittent vacuum readings—such as refrigerating devices, all types of tubes, vacuum bottles and jugs, manometers, thermometers, foods, neon signs, vitamins, penicillin and other products.

We can make prompt deliveries of these gauges . . . descriptive literature free on request. Write for it today.

Continental Electric Co., *Geneva, Ill.*

CHICAGO OFFICE: 903 MERCHANDISE MART · NEW YORK OFFICE: 265 WEST 14TH STREET

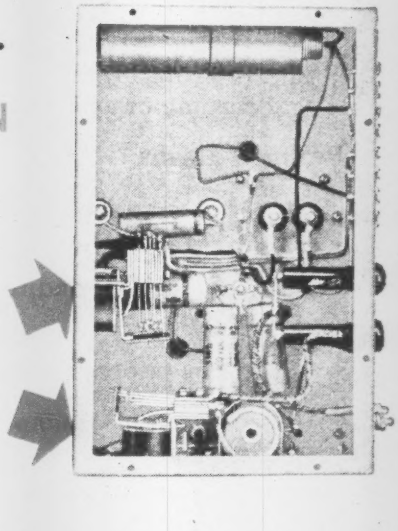
relays

IN MARINE COMMUNICATIONS

From ship to ship and from ship to shore—whether on war craft or on peacetime boats of commerce and travel—marine radio communications equipment plays a major role. Leading manufacturers of such equipment use Relays by Guardian, two of which are shown installed in the DC power supply unit of the HT-11 Radiophone manufactured by the Hallicrafters Company, Chicago.

hallicrafters
RADIOPHONE

Hallicrafters HT-11 Radiophone
Unit Showing DC Power Supply



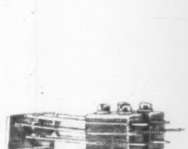
for Automatic Control of Electrical Circuits...

THERE'S A *Relay* BY GUARDIAN

In this application one Guardian relay in its normal position feeds the input of the Vibrapack for receiving purposes. On the changeover from receiving to transmitting it disconnects the Vibrapack and simultaneously energizes the other relay. This in turn connects the Dynamotor input and output circuits.

Both relays are Guardian Series 115 with double wound coils for operation on 6 or 12 volts D.C. with the 6 volt winding in parallel and the 12 volt winding in series. It is a small, compact relay, ideal for use where space is limited.

Its use in Marine Radiotelephone is but one illustration of the many applications of relays in radio and electronic equipment. For complete description of numerous types of Relays by Guardian, write for Guardian's new Catalog No. 10.

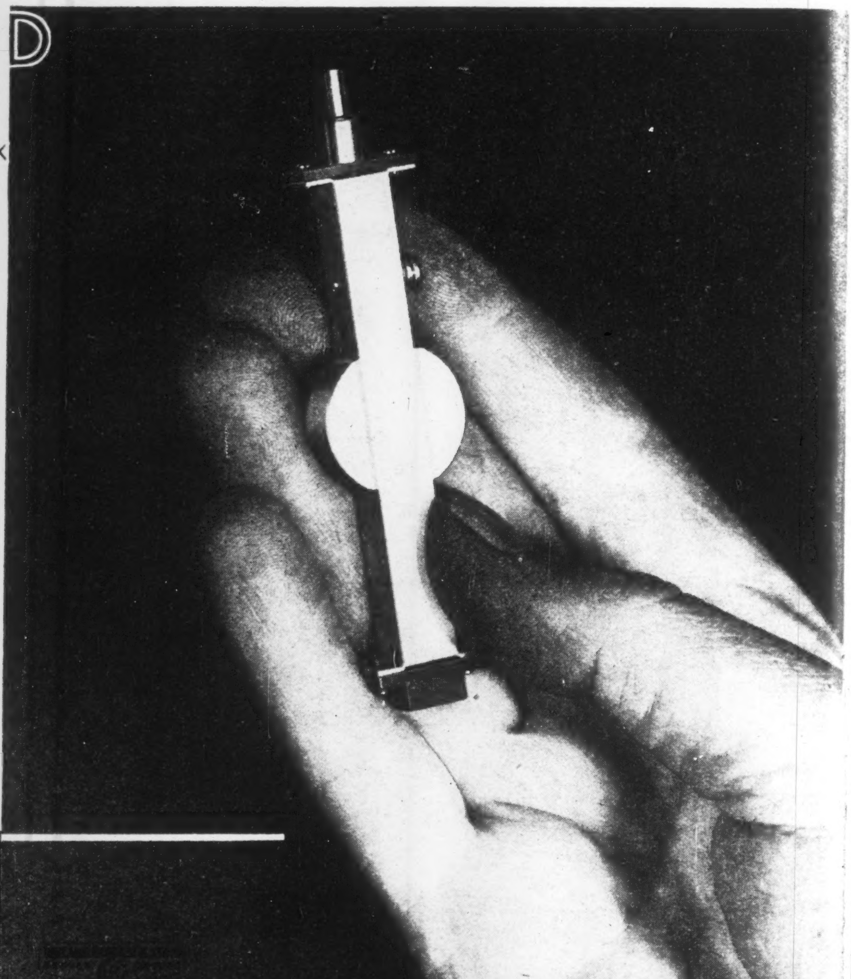


Series 115 DC Relay

GUARDIAN G ELECTRIC

1638-D W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



HEILAND

TRADE HR MARK

A SUPERIOR

OSCILLOGRAPH GALVANOMETER

with 12 exclusive features:

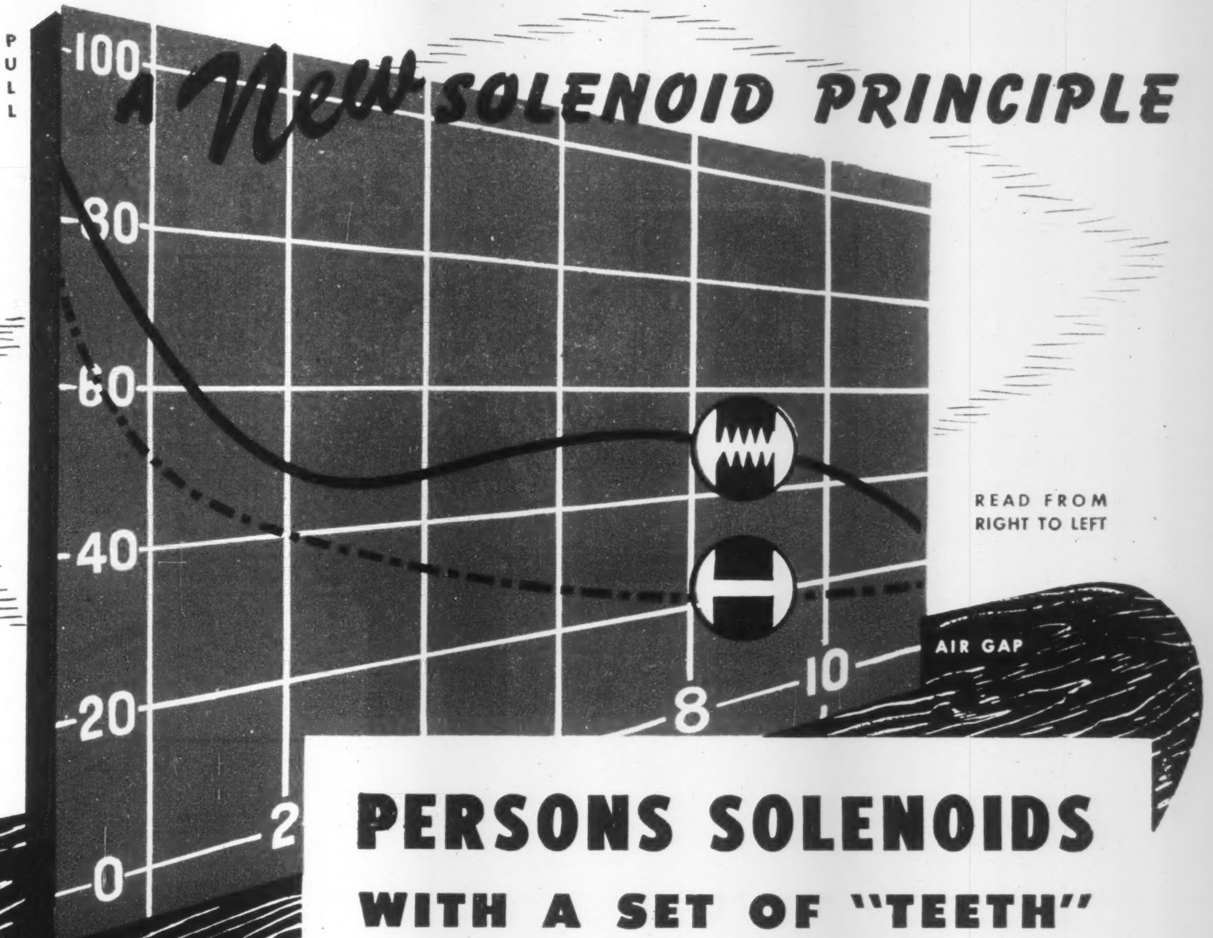
1. Small transverse dimension (¼-inch) making for small overall width of multiple galvanometer assemblies.
2. Small height.
3. Easy horizontal spot-adjustment by rotation of torsion head.
4. Easy vertical spot-adjustment by tilting in pole assembly.
5. Excellent photographic reproduction.
6. Electromagnetic damping in lower audio-frequencies.
7. Low sensitivity to mechanical vibrations.
8. Rugged construction—well protected against breakage.
9. High current-sensitivity.
10. Both terminals ungrounded.
11. Clip-type connectors, readily removed.
12. Available in a number of frequency ranges.

Write for Literature

HEILAND RESEARCH CORPORATION

DENVER 3, COLORADO

A *New* SOLENOID PRINCIPLE



PERSONS SOLENOIDS

WITH A SET OF "TEETH"

(U. S. Patent Pending)

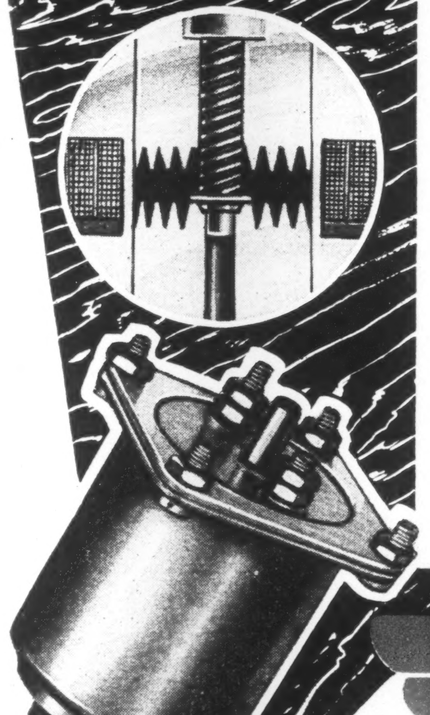
The matched interlocking teeth on plug and plunger reduce the air gap and its initial reluctance.

Result: a lighter, more compact solenoid for a given job that will generate maximum power right at the start of the stroke WHERE IT IS NEEDED. Slower acceleration rate at end of the stroke means less "slap"

Note the far greater power output at the start of the Persons stroke. This better overcomes initial friction and inertia, and frequently permits use of a smaller solenoid using less current.

Many standard models are AVAILABLE IMMEDIATELY, adaptable for countless applications. Send for our bulletin or consult our engineering department for special designs.

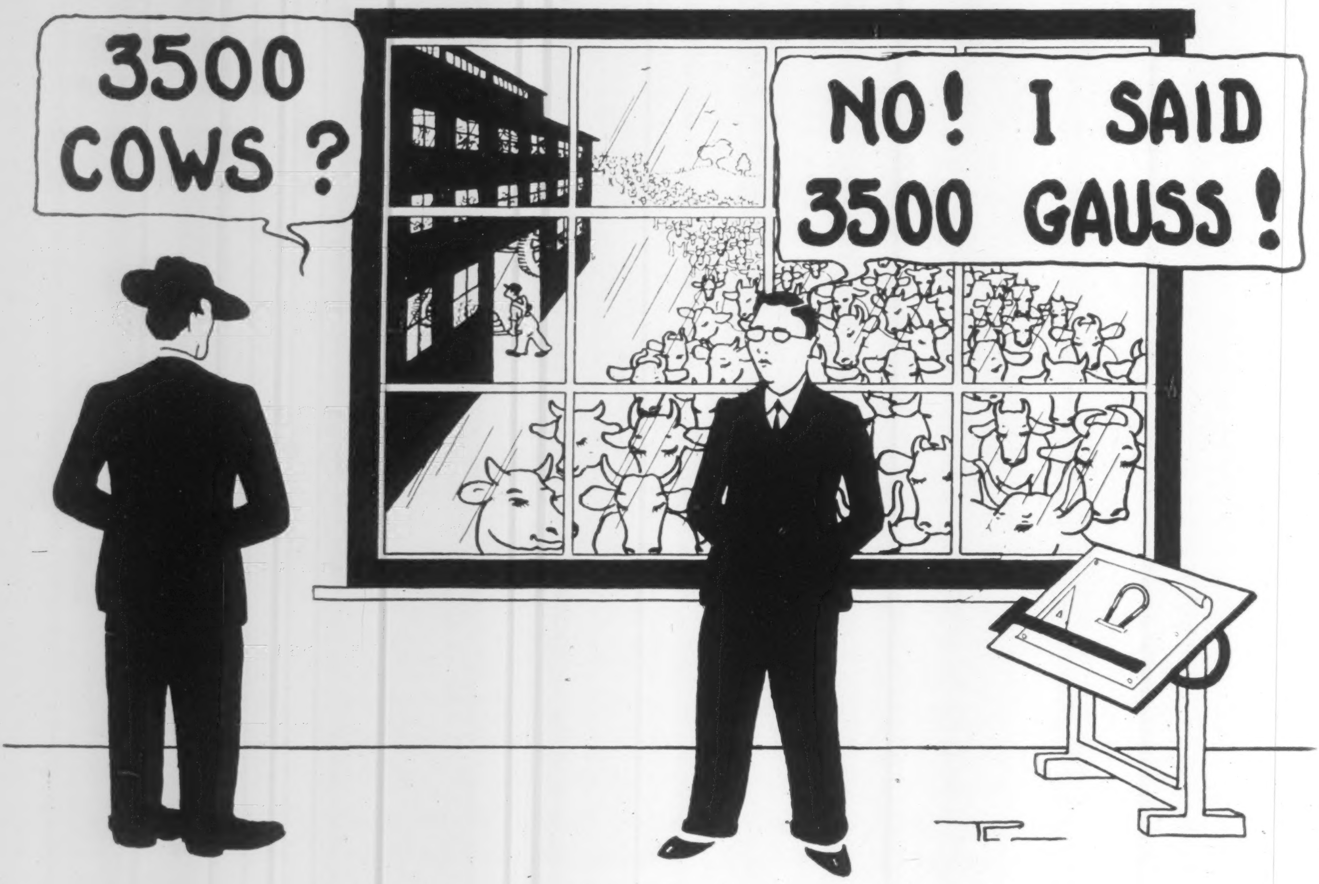
FOR BETTER SOLENOIDS WE ARE THE "PERSONS" TO SEE



LMP

L. M. PERSONS CORPORATION

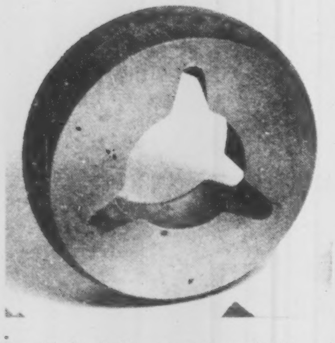
SAINT LOUIS 10, MISSOURI


3500 COWS ?
NO! I SAID 3500 GAUSS !

● With red points as scarce as they are, this mistake is understandable but, when a design engineer says he wants a field of 3500 GAUSS, the chances are good that he has something else in mind—possibly a permanent magnet.

And if it is a permanent magnet, it's an odds-on bet that he'll be tough about such details as size, shape, weight, allowances for grinding and other factors he considers essential.

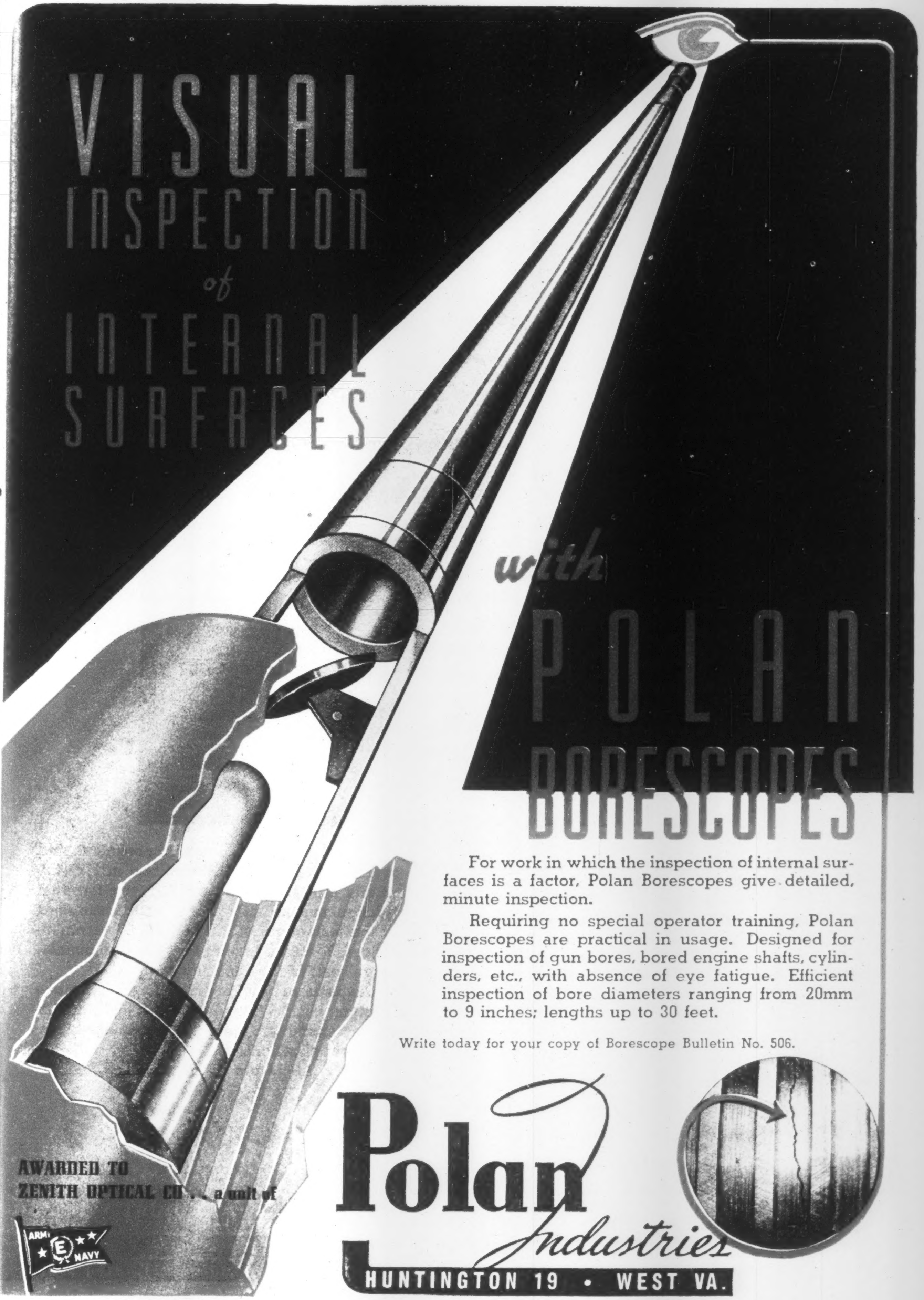
Neatest way out of any such situation is to humor him—"Yes" him—tell him to stay right where he is while you get in touch with Cinaudagraph, where they speak his language.



Typical of the many varieties of Permanent Magnets designed and made by CINAUDAGRAPH

CINAUDAGRAPH
CORPORATION

4 SELLECK STREET STAMFORD, CONN.



VISUAL INSPECTION *of* INTERNAL SURFACES

with POLAN BORESCOPES

For work in which the inspection of internal surfaces is a factor, Polan Borescopes give detailed, minute inspection.

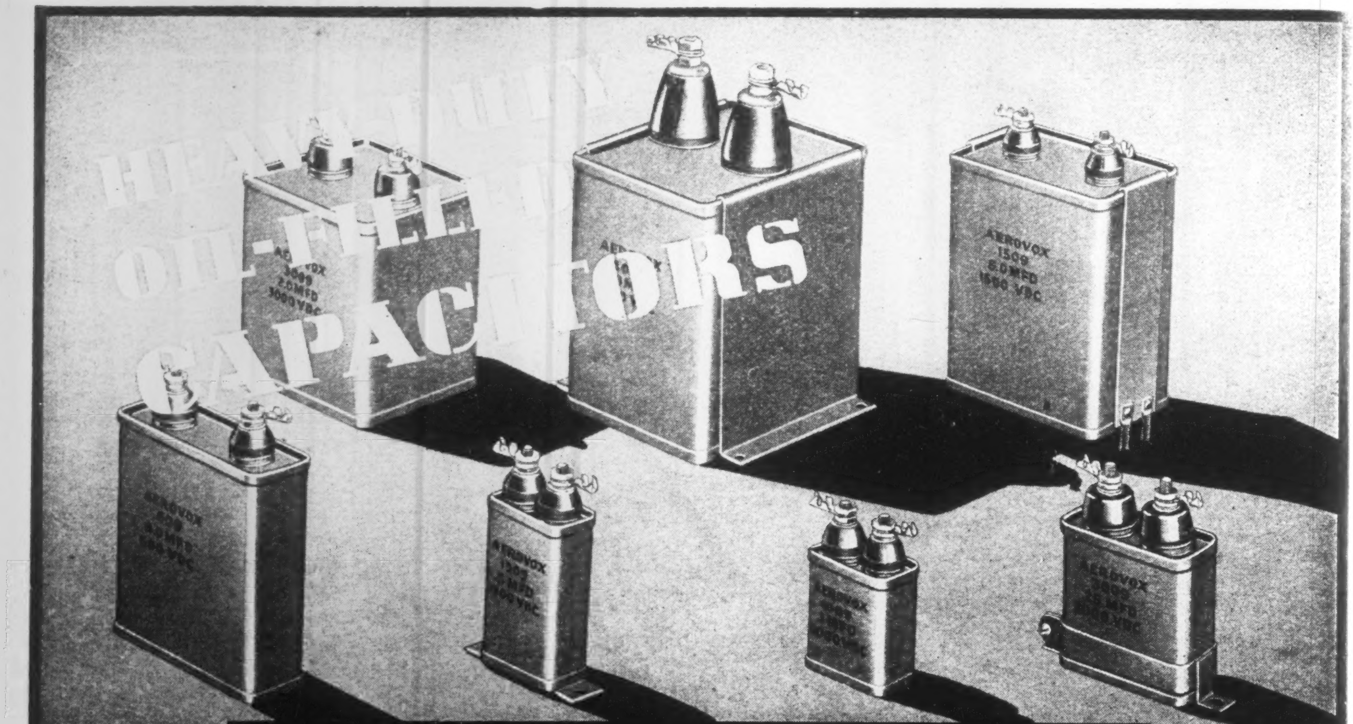
Requiring no special operator training, Polan Borescopes are practical in usage. Designed for inspection of gun bores, bored engine shafts, cylinders, etc., with absence of eye fatigue. Efficient inspection of bore diameters ranging from 20mm to 9 inches; lengths up to 30 feet.

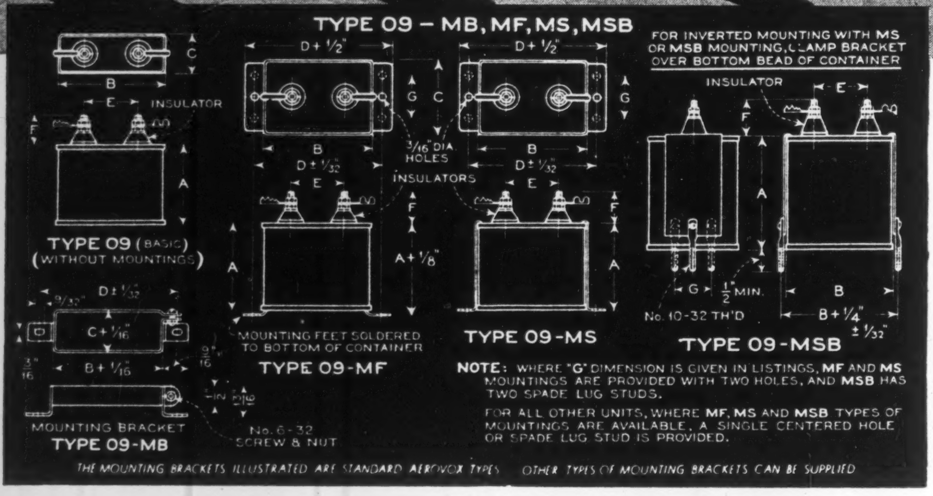
Write today for your copy of Borescope Bulletin No. 506.

AWARDED TO
ZENITH OPTICAL CO. . . a unit of

ARMY ★ E ★ NAVY

Polan *Industries*
HUNTINGTON 19 • WEST VA.


HEAVY-DUTY
OIL-FILLED
CAPACITORS
AEROVOX
1509
8.0 MFD
1500 VDC


TYPE 09 – MB, MF, MS, MSB
C
B
E
INSULATOR
F
A
TYPE 09 (BASIC)
(WITHOUT MOUNTINGS)
D ± 1/32"
9/32"
C + 1/16"
3/16"
B + 1/16"
9/16"
MOUNTING BRACKET
TYPE 09-MB
No. 6-32
SCREW & NUT
D + 1/2"
G
3/16" DIA
HOLES
INSULATORS
A + 1/8"
MOUNTING FEET SOLDERED
TO BOTTOM OF CONTAINER
TYPE 09-MF
TYPE 09-MS
FOR INVERTED MOUNTING WITH MS
OR MSB MOUNTING, CLAMP BRACKET
OVER BOTTOM BEAD OF CONTAINER
1/2" MIN.
No. 10-32 TH'D
B + 1/4"
± 1/32"
TYPE 09-MSB

NOTE: WHERE "G" DIMENSION IS GIVEN IN LISTINGS, **MF** AND **MS** MOUNTINGS ARE PROVIDED WITH TWO HOLES, AND **MSB** HAS TWO SPADE LUG STUDS.

FOR ALL OTHER UNITS, WHERE **MF**, **MS** AND **MSB** TYPES OF MOUNTINGS ARE AVAILABLE, A SINGLE CENTERED HOLE OR SPADE LUG STUD IS PROVIDED.

THE MOUNTING BRACKETS ILLUSTRATED ARE STANDARD AEROVOX TYPES   OTHER TYPES OF MOUNTING BRACKETS CAN BE SUPPLIED

- **VERSATILITY** – with economy of chassis space and assembly operations a prime factor – distinguishes Aerovox Type 09 oil-filled capacitors. Although mass-produced, this type is available in such an outstanding range of voltage and capacitance ratings, as well as mountings, that it is virtually custom-made for most high-voltage heavy-duty applications.

Note particularly the choice of mounting means. Mounting means brackets shown in drawing are Aerovox standard; other types can be supplied.

Voltage ratings from 600 to 7500 D.C.W. Widest selection of capacitance values. Impregnants and fills available are HYVOL (Vegetable) or HYVOL M (mineral oil). The exclusive Aerovox terminal construction means units that pass the standard immersion tests required by various Governmental services. Terminal assembly is non-removable, an integral part of the capacitor.

These capacitors provide maximum capacitance at minimum cost. Widely used for continuous-service in transmitters, amplifiers, rectifier filters and similar applications.

- *Literature on Request*

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 13 E. 40 ST., NEW YORK 16, N. Y. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

THE NEW CONSOLIDATED TYPE 1-110 VIBROMETER

FAST
ACCURATE
DEPENDABLE

THE CONSOLIDATED Type 1-110 Vibrometer consists of a linear and integrating amplifier with horizontal and vertical velocity type pickups. This instrument provides a fast, accurate, dependable means of determining average velocity or peak-to-peak displacement.

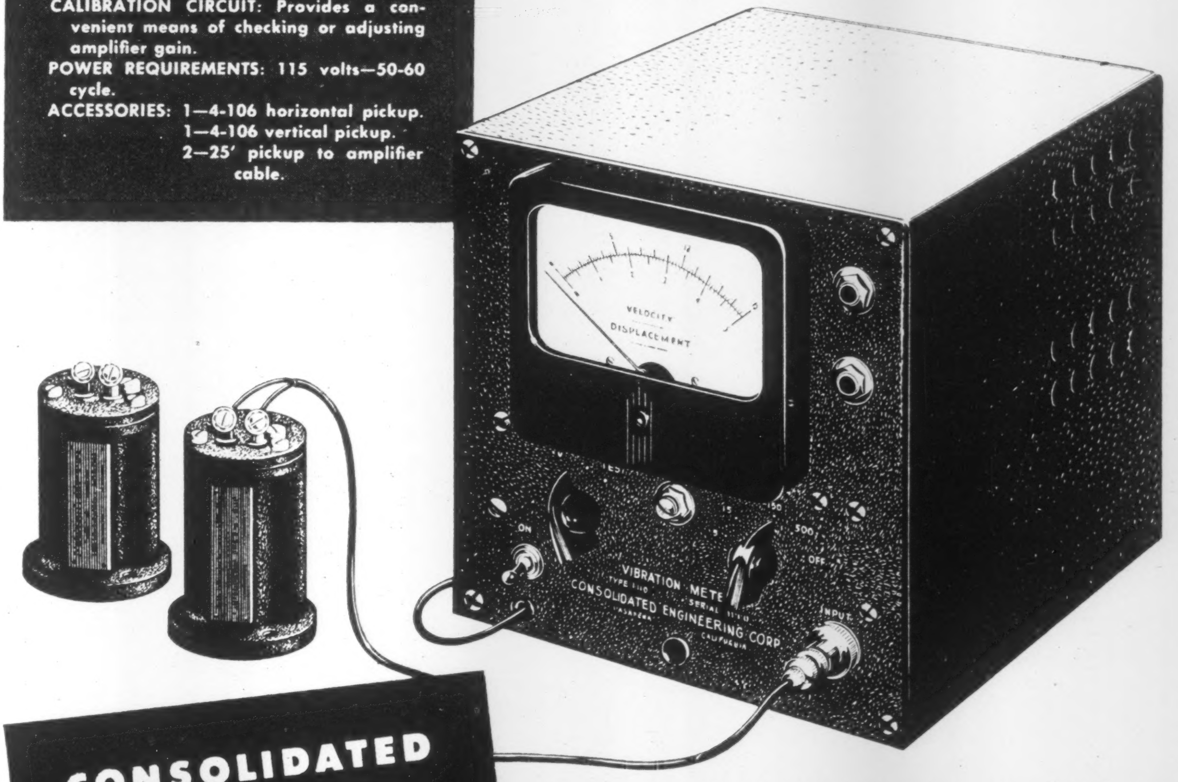
SPECIAL FEATURES

- **VERY COMPACT:** 8" x 8" x 8". Weight—12½ lbs. including 2 pickups and cables.
- **FIVE SCALE RANGES:** Peak to Peak displacement—.005 - .015 - .050 - .150 and .500 inches. Average velocity—5 - 15 - 50 - 150 - 500 inches per second.
- **TWO OUTPUT JACKS PROVIDED:** Jacks permit use with oscilloscope or external meter.
- **FREQUENCY RANGE:** Amplifier linear from 5 cps. to 100 cps.
- **CALIBRATION CIRCUIT:** Provides a convenient means of checking or adjusting amplifier gain.
- **POWER REQUIREMENTS:** 115 volts—50-60 cycle.
- **ACCESSORIES:** 1—4-106 horizontal pickup.
  1—4-106 vertical pickup.
  2—25' pickup to amplifier cable.

The unit contains a combination linear and integrating amplifier either of which may be chosen by a selector switch on the front panel.

In the integrating position peak-to-peak displacement may be read directly from the meter on the front panel. When used in the linear position, average velocity is indicated.

Write to Department 4A for details!

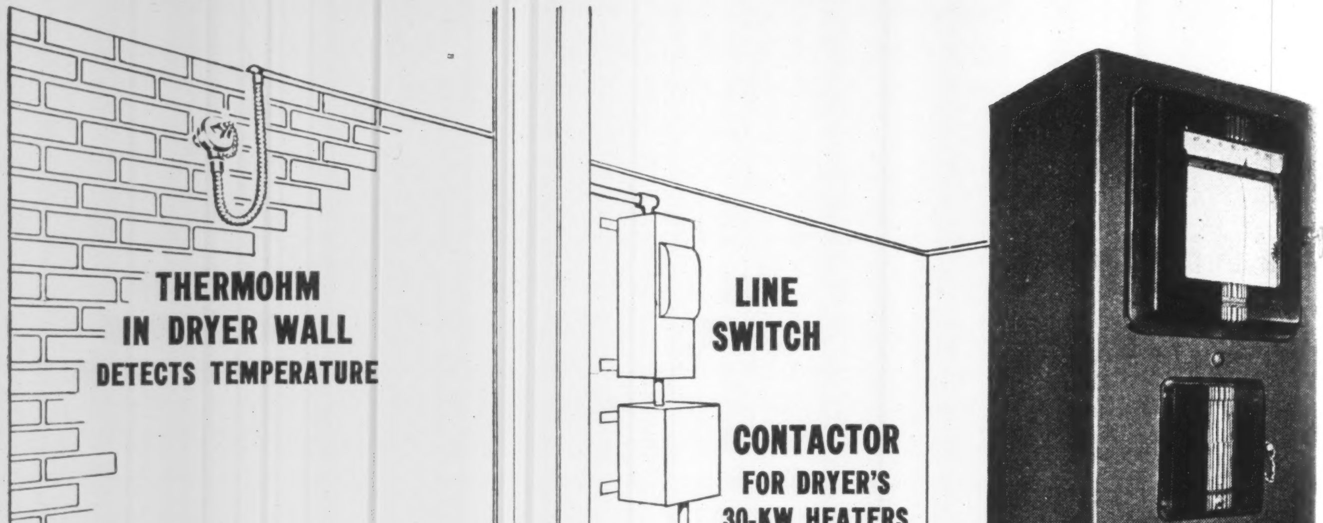


CONSOLIDATED ENGINEERING CORPORATION
Herbert Hoover, Jr., President

ARMY E NAVY

595 EAST COLORADO STREET • PASADENA, CALIF.

SPECIALIZING IN VIBRATION AND STRAIN MEASUREMENT



Arrangement of equipment in which a Micromax Controller automatically holds temperature to a preset program in a coke-products dryer at the Niagara Falls plant of International Graphite & Electrode Corp.

Dryer's Temperature Program Closely Regulated By MICROMAX CONTROLLER

The temperature program held by the above-pictured Micromax Controller can last as long as 30 days, and can be quite intricate or quite simple. The rate of temperature increase per day can be changed in large or small amounts, and any desired soaking temperature can be held as long as desired. The control is entirely automatic—the Micromax is preset for the complete cycle, and takes complete charge of switching electric power to the dryer's 30-kw heater. Because many war products require careful and accurate drying, International Graphite's solution of the temperature-control problem has wide application in industry.

A Micromax Controller, using a Thermohm (L & N electrical resistance-thermometer bulb) as its temperature detector, is ideal for this Program Control service, for a number of reasons:

1. The Thermohm is sensitive and accurate not only at the highest drying temperatures but also at the room temperature where the process starts.

2. The Thermohm is as sturdy as a thermocouple and, like a couple, can be replaced if ever necessary without any effect on the rest of the control system.

3. The Micromax Recording Controller can be as sensitive at 350 feet from the dryer as though it were 35 feet away; and it is connected to the Thermohm and the control relays only by ordinary electric cable.

4. Micromax is highly dependable on heavy-duty work. It is not only sensitive and accurate, but is strongly made and permanently adjusted to hold its dependability of operation. And it can be made for thermocouples or Rayotubes instead of Thermohms; with control to meet fully the needs of any controllable furnace or dryer. An L & N engineer will either help apply Micromax to a specific problem, or send the appropriate catalog, as you prefer.

Jrl Ad N-33C(4)

ARMY E NAVY
V depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4955 STENTON AVE., PHILA. 44, PA

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Instruments THE MAGAZINE OF Measurement and Control
M. F. BEHAR, Editor

"Benefits of a National Instrument Society"

Prepared by the COMMITTEE ON A CONSTITUTION, representing the two Intersociety Conferences on the Formation of a National Instrument Society, held in New York on Dec. 2, 1944 and in Chicago on Feb. 17, 1945:

R. C. Darnell, *Chairman*	Instrument Society of Washington
H. F. Moore	Society for Measurement and Control (New Jersey)
W. H. White	Philadelphia Society for Instrumentation
ADVISORY MEMBERS	
C. O. Fairchild	New York Society for Measurement and Control
J. E. Gambrill	Philadelphia Society for Instrumentation
Richard Rimbach	American Society for Measurement and Control
W. A. Wildhack	Instrument Society of Washington

THE question is asked; "Why have a national society?" Perhaps it would be more to the point to ask why have a local society? A score of local instrument societies have been formed and are functioning satisfactorily because so many of us have found it desirable and beneficial to get together with friends and associates who understand our language and like to talk about things we ourselves are interested in.

The question, "What can I get out of it?" has already been answered in a satisfactory manner for more than two thousand of us who are attending the meetings of these local groups.

The question now is, "What more can I get out of a national society?" Could a national society sufficiently increase the benefits accruing to members to offset the possible increase in dues? The existence and extensive membership of active national scientific and engineering societies demonstrates that group objectives can be more effectively promoted by a national society than by scattered and unrelated local societies.

Membership in an organization devoted to high ideals and worthwhile objectives will give each individual member an increased awareness that his efforts to improve his own technical competence and to advance the art or science of his chosen field are contributing to the progress of technical civilization and to the welfare of his fellow-men. General recognition of the aims and accomplishments of such a society will inevitably increase the public esteem and prestige of its members.

The society could be of assistance to every member by sponsoring the publication of books, reports and symposia relating to instruments and by publishing a journal for technical and survey articles, abstracts of current instrument literature, and society news. The society could hold national and regional meetings for the presentation and discussion of technical papers. Concurrently with these meetings, exhibits of instruments and components could be sponsored which would not only be a source of income but would advertise the society and the work of its members and give instrument users an opportunity to examine instruments and components and learn of new developments in the industry.

The society could foster the establishment, by schools and colleges, of regular and extension courses in the principles and use of instruments for the training of scientists, engineers and technicians. The society could encourage the establishment of four-year curricula and graduate studies in Instrument Engineering. The society could contribute toward the advancement of the arts and sciences relating to the theory, design, manufacture and use of instruments by encouraging research, tests and other original work.

Growth of the instrument industry could be stimulated by establishing better contact between instrument manufacturers and users, thereby bringing about a clearer understanding of their mutual problems. This would promote the development of special instruments for special applications, the finding of new applications for instruments, and the improvement of existing instruments to meet the user's needs.

The national society could assist in clarifying instrument nomenclature by establishing acceptable terminology for all branches of the instrument field.

The national society could adopt and promote standards applying to instrument design, manufacture and use.

The national society could assist the local chapters by furnishing guidance in the selection of qualified speakers, choice of programs for their particular membership, in the conduct of their meetings and other activities with the view to maintaining therein a high level of interest and value to the members. Much of the clerical work of the locals could be taken over by the national office, such as collection of dues, issuance of membership cards and certificates, printing of programs, providing of publicity material, etc. The organization of new chapters in suitable communities, where none existed, could be sponsored and aided by the national society through arranging organization meetings, providing speakers, printed announcements, etc., and by defraying the expenses of organization.

The national society could maintain a placement service for its members: listing both positions available and positions wanted. The standards of employment in the instrument field could be enhanced by selective publicity given to favorable conditions of employment and pay and by refusal to list or fill applications in which the pay and working conditions are substandard.

The society could provide a library of books and papers relating to instruments and provide a catalog service through the national office. The library would serve as a depository for copies of papers presented before local and national meetings thus making them available to all members. The catalog service could provide a record of all types of instruments and their manufacturers, to include newly-developed instruments and new uses and applications for research and development work.

There is no doubt that the INSTRUMENT SOCIETY OF AMERICA will contribute professionally, technically and economically to its members. Scientific and technical workers concerned with instruments in any way will do well to lend their support to the Society by becoming members, thereby securing these many benefits for themselves and their fellow-workers.

Hail to the Army!

OLD subscribers may remember my habit of using this page, in April of every odd-numbered year, to boost National Defense and—in particular—the Army to which I belonged (and still belong!). On this 1945 Army Day, however, no printed editorial can compare with the glorious epic being written by the Army itself.—MFB

INSTRUMENTATION

By CHARLES BELKNAP, Presiden

IN order to understand why you invited me, an unskilled instrument man, to speak this evening, I read over the preamble to your constitution. Frankly, I found myself an outsider until I came to a phrase which read: "Objective—to study the *benefits derived* from instrument application."

That is a position I have been in for quite a few years—receiving and appreciating the *benefits derived* from the application and use of instruments. During my twenty years' service in the Navy, I knew what it meant to rely on the instruments which the Naval Academy had taught me to use as a Naval Officer, and it is my understanding that the Navy now has many more vital instruments in its equipment which have increased its efficiency far beyond the days when I was in the Navy. I have in mind such instruments as radar, the instrument which permits guns to be laid on their targets with great accuracy from miles away night or day; searchlights to be quickly and accurately trained on an enemy ship; the sonic depth recording instrument which continuously tells the navigator of a ship the depth of water beneath his ship, which is of inestimable value in navigation as a comparison of the recorded depths with those on the chart can be used with fair accuracy in locating the position of the ship, in fair, foul or foggy weather. Along with radar and sonic depth finder goes the vastly improved optical range finder, which is used in fair weather for laying of guns and for navigational purposes.

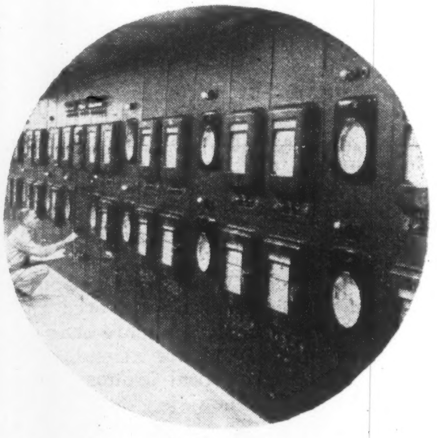
That Navy of ours, back in 1918, was as neatly and fully instrumented with the last word in fire control, engine-room devices and navigation helps, as any other in the world. Not only did I learn to appreciate my instruction in their use, but I realized that which should be obvious—Man's brain is the greatest of all instruments.

In 1922, when I was in the Merrimac Chemical Company in Boston, which Company is now a part of Monsanto, I wrote an article for the Company publication about organization and cited the human body as being the highest type of organization with the brain as its governing instrument. In this article I quoted from a then recent publication on this subject which had impressed me greatly. As it somewhat follows th lines in which your interests lie, I a going to quote a few points which r late to the brain as a master of a instruments, and its application to a organization:

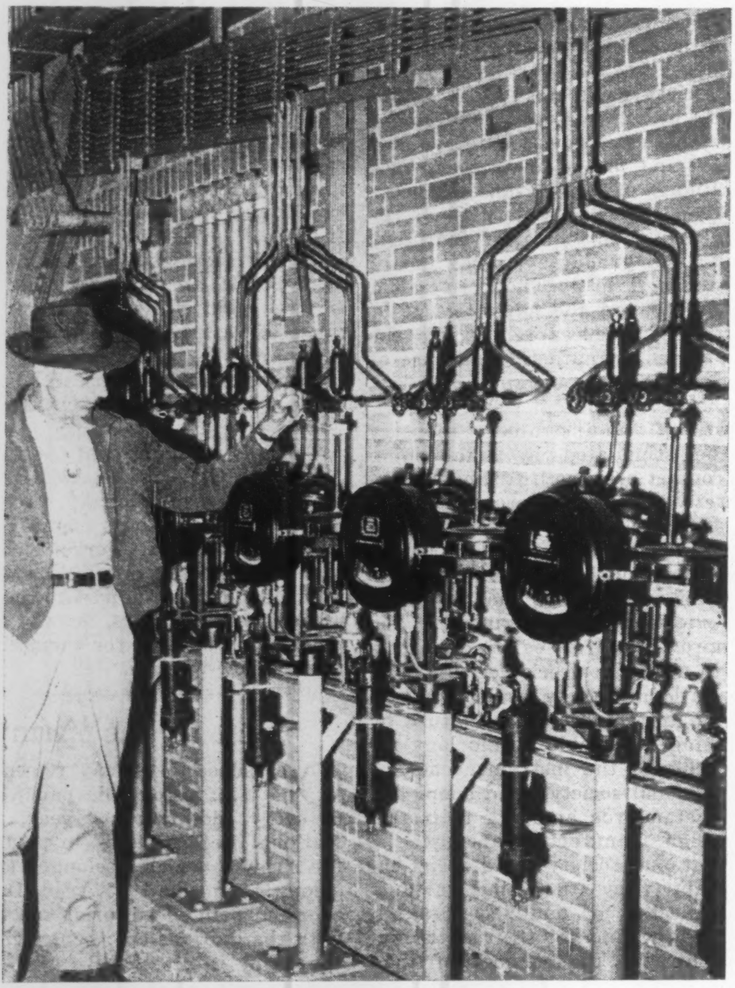
"The principal aim of the huma body is economy in the expenditure o energy. The first lesson it teaches u concerns the proper delegation of authority. No matter from which point instructions are received, the brain decides and then delegates the task to b done to that particular function designed to perform the task. The heart never attempts to breathe, the ear does not make an effort to see, the tongue t smell nor the stomach to carry blood from place to place. Everywhere the work is done by specialists. There is centralization; the body does not tolerate lines of divided authority. There is no indecision as regards what is to be done—each organ acts definitely and promptly.

"In the operation of this wonderful organization there is no interference by major officials in the work of other major officials, nor in the work to be done by minor officials. The body is a 'WE' proposition and not an 'I' affair. Fingers are not under the jurisdiction of the lungs and the stomach is not ordered about by the heart. *No one executive pretends to know it all.* Advice from all sources is given respectful attention and acted upon immediately. Routine performance proceeds unhampered and without interruption. The hands and feet do not wait until the heart has pumped a certain amount of

IN MONSANTO PLANTS



Typical is the Texas City Styrene Plant. Its dehydrogenation unit control room *(above)* was the cover photo of our July 1943 issue. Equally neat are installations not in control rooms: note for example the correct piping of the flow-rate job at the left.



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*Talk before the St. Louis Society for Instrumentation.

SPELLS PROGRESS

Monsanto Chemical Co., St. Louis, Mo.

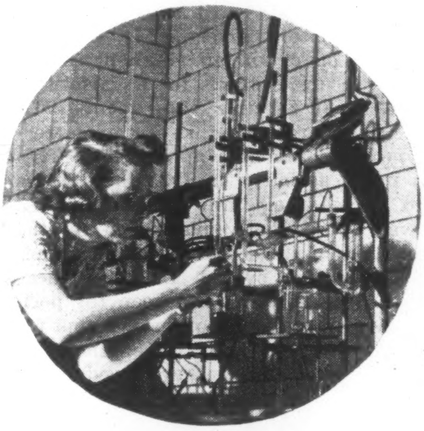
food, or the stomach digested a definite quantity of food."

Man has yet to invent and construct something as great as himself, and a control instrument as precise as the brain.

They say that our aviators find it advantageous at times to give their planes over to the control of their robot-pilots, those instruments that automatically hold altitude and course. However, our flyers are constantly rechecking and guarding their operational data. The master instrument, the brain, checks the mechanical, and the result is increased safety and greater precision.

All instruments can be loosely called robots and there are a greater number being developed and used today than ever before. Our present Navy, Army and Air Corps, equipped as they are with the finest the world has ever seen, will make the new and now secret ones available to us all in the days of peace to follow.

AND LABORATORIES



Above: Delicate chemical measurements are made in the Control Laboratory of the John T. Queeny Plant at St. Louis. *Right:* Cast phenolic unit pilot plant in Monsanto's new Plastics Research Laboratory at Springfield, Mass.

During these days of war, industry itself, efficiently geared to increased production, is also contributing many more. Time-saving, labor-saving and product-saving instruments ingeniously contrived to meet the demands of the day are becoming a part of industry's sensory system.

Someone has said that the states of civilization or ages of man are named and plotted by archaeologists from the study of man's development of tools. The Stone, Bronze and Iron Ages are examples. The inventor of a new tool, or instrument, increases the vista of exploration, development and production. He is literally "making his head save his heels"—and millions of others as well.

It is hard to say whether the design and development of new tools, measuring devices and controls are entirely responsible for the tremendous strides in scientific discovery, but it can be said without fear of contradiction that they go hand in hand. The last fifty years there has been an ever-increasing number of instruments invented and applied each year. It was during the last war that the petroleum and rubber industries became highly instrumented and today they are held up to us as examples of instrument-controlled production approaching perfection.

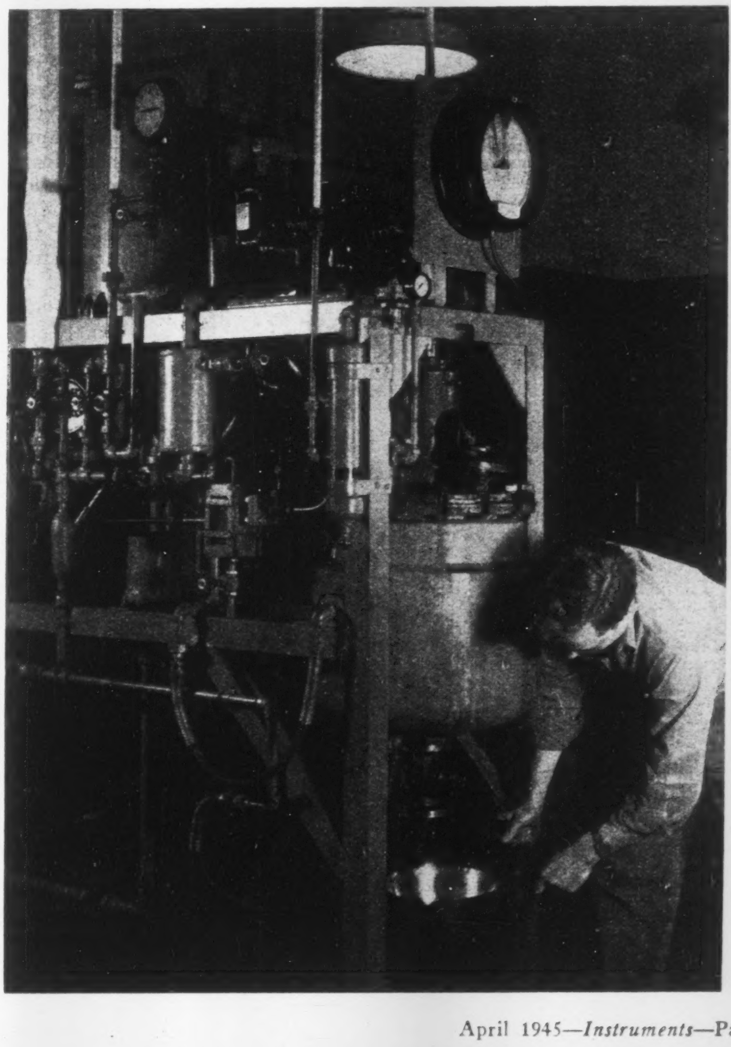
During these days of war, many are the needs for man-hour-saving instruments that effect economies of design, more accurate control of the product, and continuous batch processes. The post-war list of instrumented streamlined industries will be long and encouraging. Modern engineering for the production of synthetics will be among those present, for they require close and accurate control in manufacture.

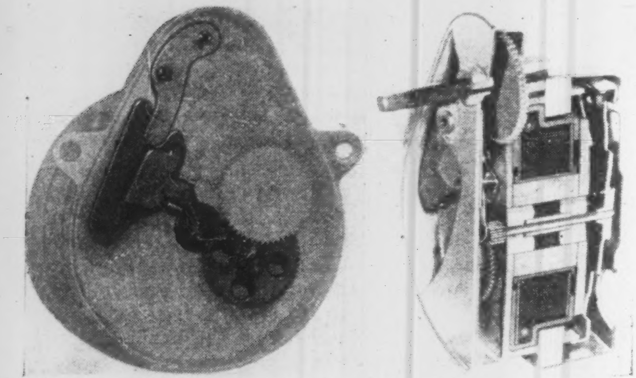
But this recognition of automatic help and control has come within the lives of each of us. Back in the good old days when steel was steel and not an alloy, pyrometers were considered effeminate. Those two-fisted Bessemer boys imported to this country from Sheffield and Birmingham, England, believed in taking a few knowing squints at the molten metal and yelling, "Heat her up 'til she's cherry red, then quench." No checking the brain instrument there; they were right or wrong, and much metal depended on their perception of color. Who was to know how hot was "cherry red" if the expert was not around? The old books tell us that the "red" of the steel fires ranged from 1060 degrees to 1560 degrees and at least six different terms were used to connote temperature. Blood red, dark cherry, medium cherry, light cherry and bright cherry meant temperatures but were meaningless as perfect controls. The instrument called a pyrometer took away all those glamorous colorful names and replaced them with precise reading.

The list is longer—and interesting only as a page of instrument history.

In the chemical industry we are ap-

Continued on page 286





Haydon Mfg. Co. motor with declutching mechanism. Counterbalanced arm throws rotor pinion out of mesh when current is off.

ELECTRIC
for Instruments and

By HARRY D'ALMAINE,

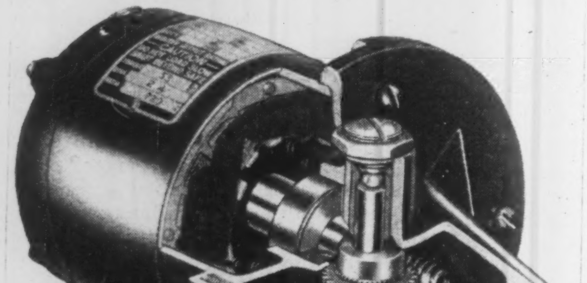
INTRODUCTION

In conducting our investigation, the results of which are presented in the following report, we quickly came to realize that our original aim, which had been to make this report complete and exhaustive, was too ambitious. The further we went, the more we became impressed with the tremendous numbers of manufacturers having a stake in these related fields of motive power devices, instruments and process control apparatus. Further, the almost endless ramifications of equipment and the industrial uses to which it is put, convinced us that it would take a grant from Congress to provide the funds, time and personnel to make it complete. We hope, however, that we have accomplished a reasonably sound review and a reasonably comprehensive one of this field.

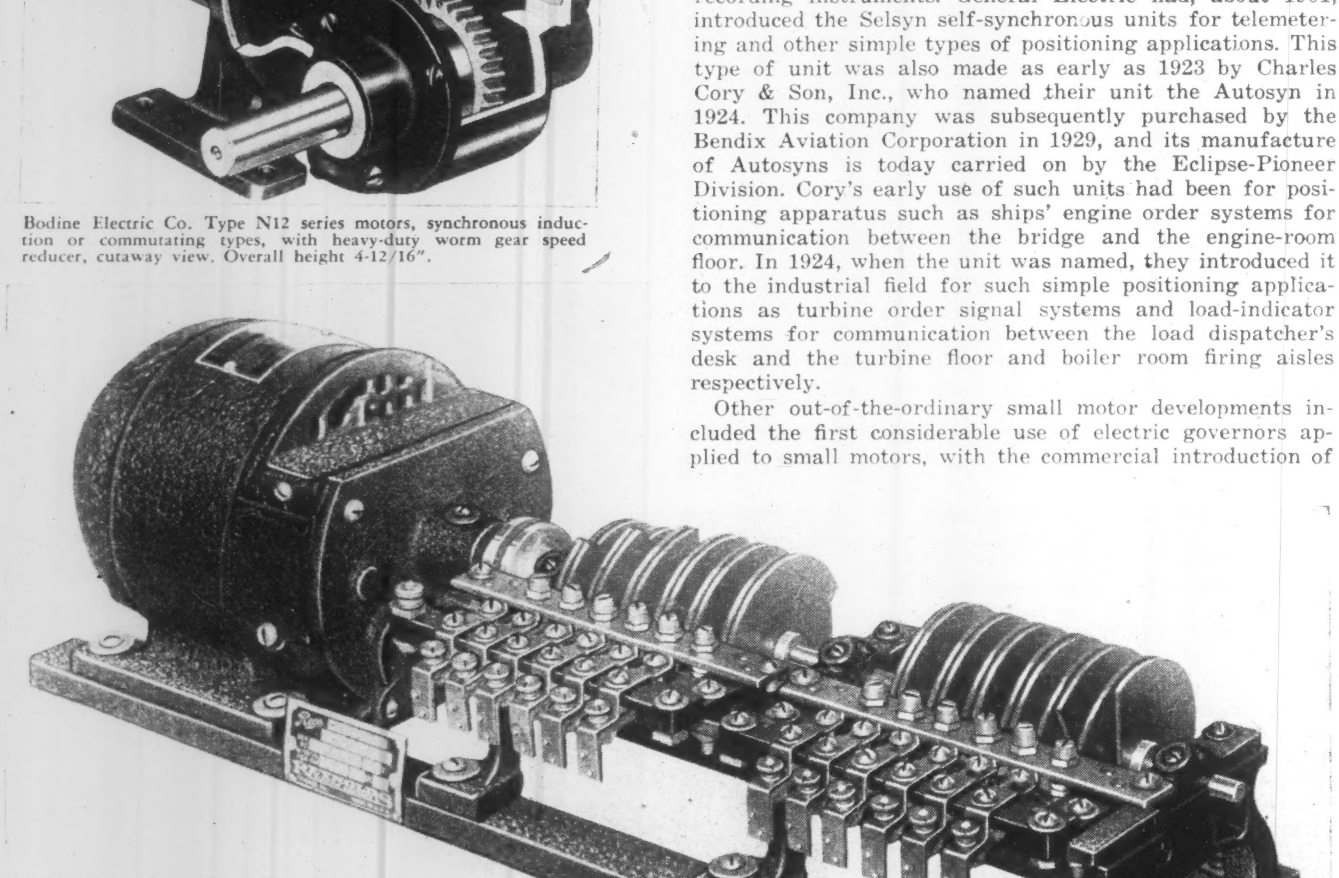
EARLY DEVELOPMENTS

PRIOR to 1929 there had been very little development of any special types of motors required for the instrument and control apparatus field aside from the tiny hysteresis synchronous motors developed by Warren Telechron and designed for operation on single-phase alternating current in order to drive charts for a variety of recording instruments. General Electric had, about 1901, introduced the Selsyn self-synchronous units for telemetering and other simple types of positioning applications. This type of unit was also made as early as 1923 by Charles Cory & Son, Inc., who named their unit the Autosyn in 1924. This company was subsequently purchased by the Bendix Aviation Corporation in 1929, and its manufacture of Autosyns is today carried on by the Eclipse-Pioneer Division. Cory's early use of such units had been for positioning apparatus such as ships' engine order systems for communication between the bridge and the engine-room floor. In 1924, when the unit was named, they introduced it to the industrial field for such simple positioning applications as turbine order signal systems and load-indicator systems for communication between the load dispatcher's desk and the turbine floor and boiler room firing aisles respectively.

Other out-of-the-ordinary small motor developments included the first considerable use of electric governors applied to small motors, with the commercial introduction of



Bodine Electric Co. Type N12 series motors, synchronous induction or commutating types, with heavy-duty worm gear speed reducer, cutaway view. Overall height 4-12/16″.



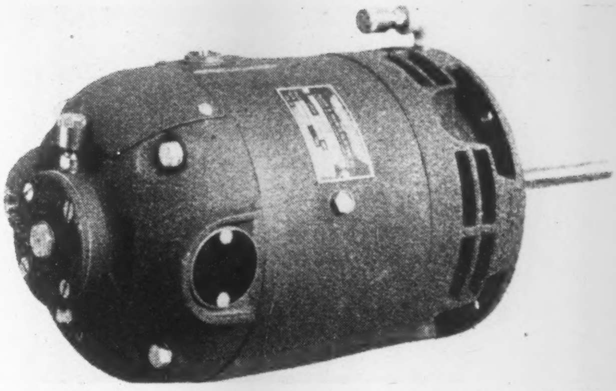
Reynolds Electric Co. "Reco Silver Contact" Control with induction disk type motor, is equipped with 3″ cams of two-piece adjustable construction. It will operate up to twelve circuits at 3 to 4 r.p.m. it has a capacity per circuit (watts or v.a.) of 1650 or 2750. Can also be equipped with 1½″ cams for faster action at 36 to 46 r.p.m. It is designed for 115-volt 50-cycle only.

MOTORS
Control Apparatus

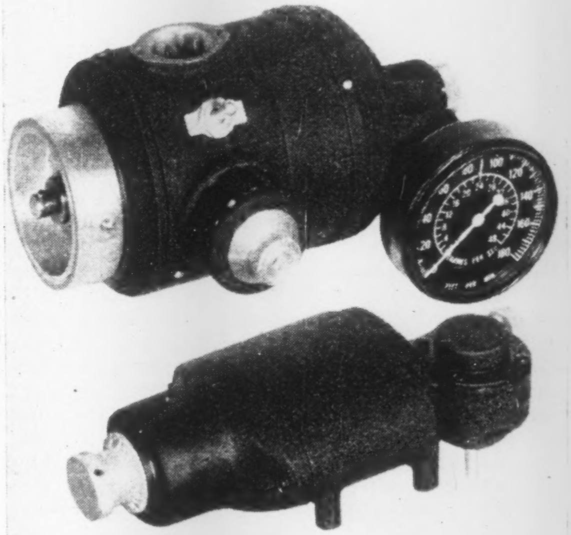
Industrial Sales Research, New York

the Lee governor about 1929. Its use prior to that time had been on only a very small scale. Electric governors were old in principle, but, until the development of the Lee governor, had not been very sensitive speed control devices. There may be earlier developments, but the oldest we are acquainted with was developed by Edison in 1882. The Lee governor owed its success to the fact that the current-interrupting contacts were not actuated by any secondary linkage involving lost motion, or handicapped by friction. The contacts on this governor were mounted directly in the centrifugal field of force so that they were sensitive to the slightest change in speed. A motor so controlled immediately offered several advantages over any other type of motor available for certain types of applications. In the first place, it permitted the use of series universal motors which packed a lot of power in a small space, but overcame the disadvantages of the sloping speed-torque curve of such motors and permitted their application to such apparatus as adjustable-speed drives on optical instruments known as squint correctors, and to string-type oscillographs, where its advantages were at once obvious as it permitted much better visual observation than was possible with the rheostat-controlled a-c. or d-c. motors previously in use. Their speed could not be kept constant and the image would wander. The governor-controlled motor also permitted improvement in other special problems of control, such as accurate d-c. substitute for synchronous motors on stand-by drives for a-c. clock systems, motion picture apparatus, and automatic oxyacetylene flame-cutting carriages.

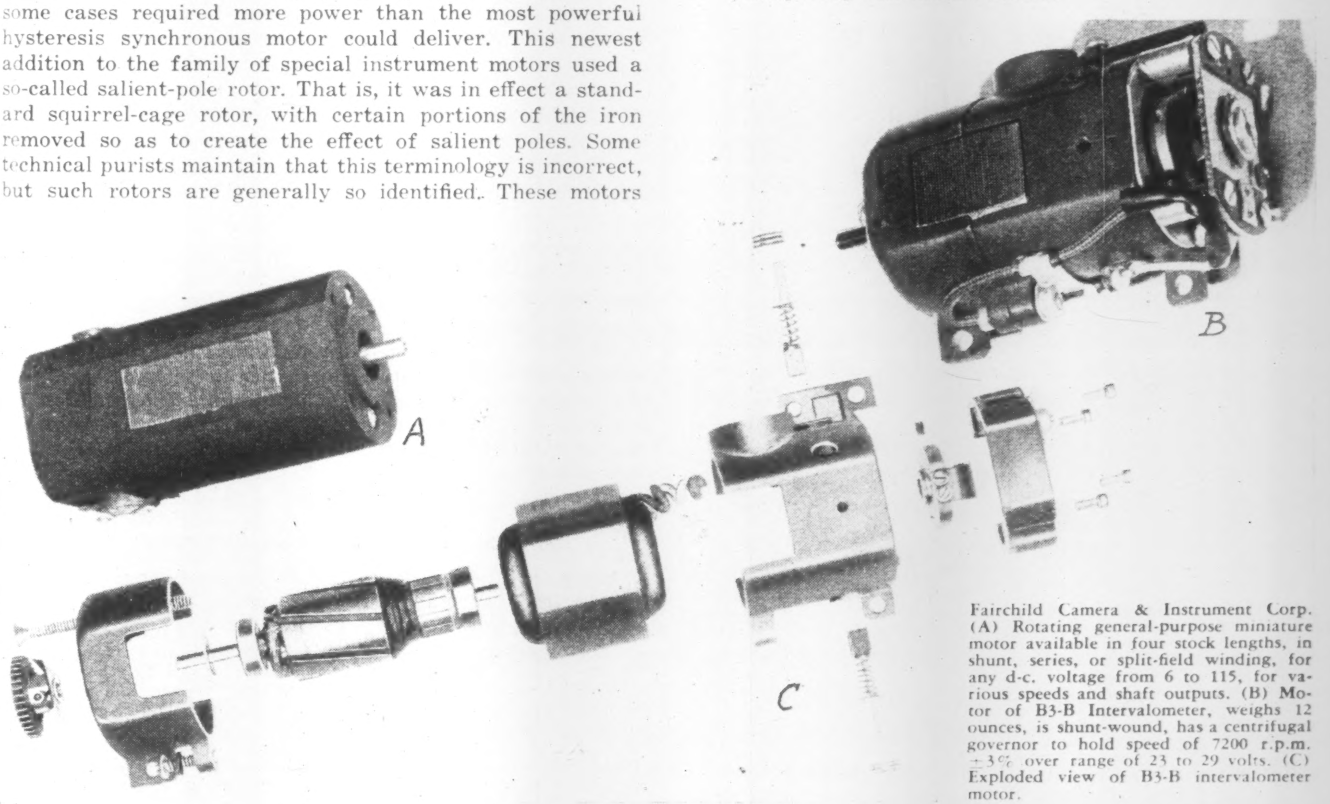
In 1932 the Bodine Electric Co. introduced what was at that time the smallest self-starting single-phase synchronous motor using a distributed wound stator. This motor had enough power to drive a variety of instruments such as temperature controllers employing depressor bars, which in some cases required more power than the most powerful hysteresis synchronous motor could deliver. This newest addition to the family of special instrument motors used a so-called salient-pole rotor. That is, it was in effect a standard squirrel-cage rotor, with certain portions of the iron removed so as to create the effect of salient poles. Some technical purists maintain that this terminology is incorrect, but such rotors are generally so identified. These motors



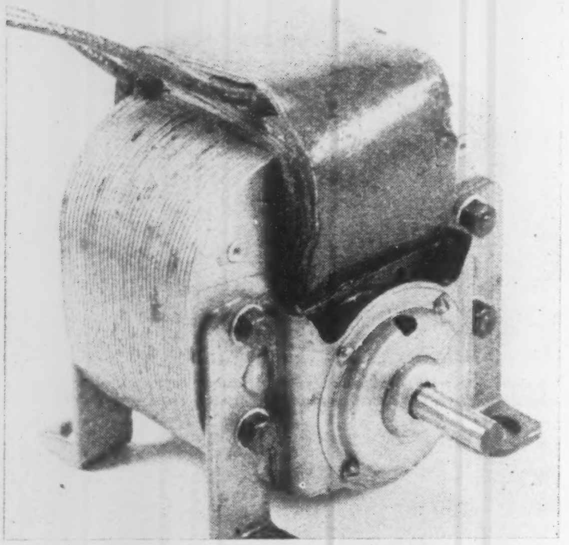
Lamb Electric Company. Compensated series motor. ¾ H.P. equipped with vertical mounting flange, for operation of valve controls.



Lee Engineering & Mfg. Co. Two examples of electric governor controlled, commutator type motors for aircraft. Both are used for operating reconnaissance cameras.



Fairchild Camera & Instrument Corp. (A) Rotating general-purpose miniature motor available in four stock lengths, in shunt, series, or split-field winding, for any d-c. voltage from 6 to 115, for various speeds and shaft outputs. (B) Motor of B3-B Intervalometer, weighs 12 ounces, is shunt-wound, has a centrifugal governor to hold speed of 7200 r.p.m. ±3% over range of 23 to 29 volts. (C) Exploded view of B3-B intervalometer motor.

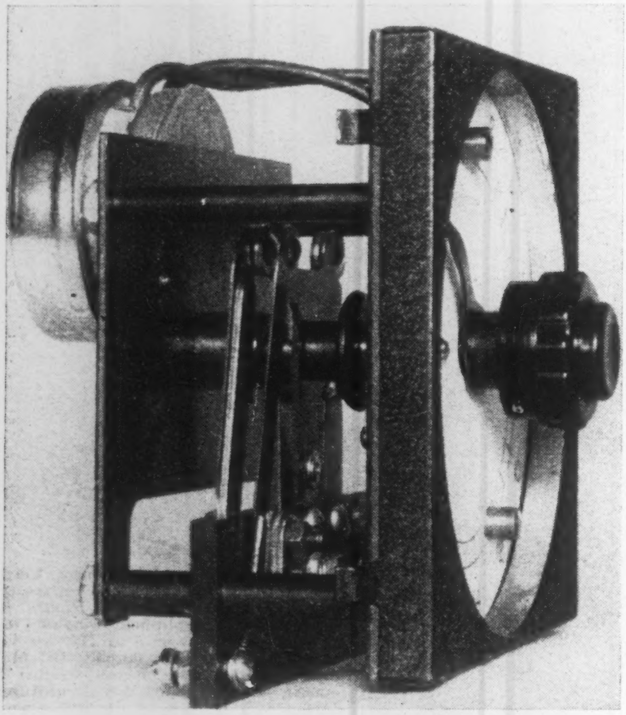


Barber-Colman Company. Type BYAR motor, available in ratings from 0.005 to 0.026 h.p. Watts input 4 to 20 watts.

were at first split-phase start and employed a centrifugal cut-out switch for the split-phase winding. They were in a frame slightly larger than 3″ in diameter.

Later, development work was carried on by both the Bodine Electric Co. and the Holtzer Cabot Electric Co. on a further contribution to the small synchronous motor field, which resulted in the introduction, about 1936, by the Holtzer Cabot Electric Co. of a unit that was approximately midway in size between a Warren Telechron motor and the Bodine synchronous motor. This new unit was in a small square-sided frame similar in external appearance to the larger motors of this design long popularized by the Leland Electric Co. Shortly after Holtzer Cabot introduced their unit, the Bodine Electric Co.'s unit made its appearance. All of these small synchronous motors were soon offered with capacitor windings for capacitor start and run performance.

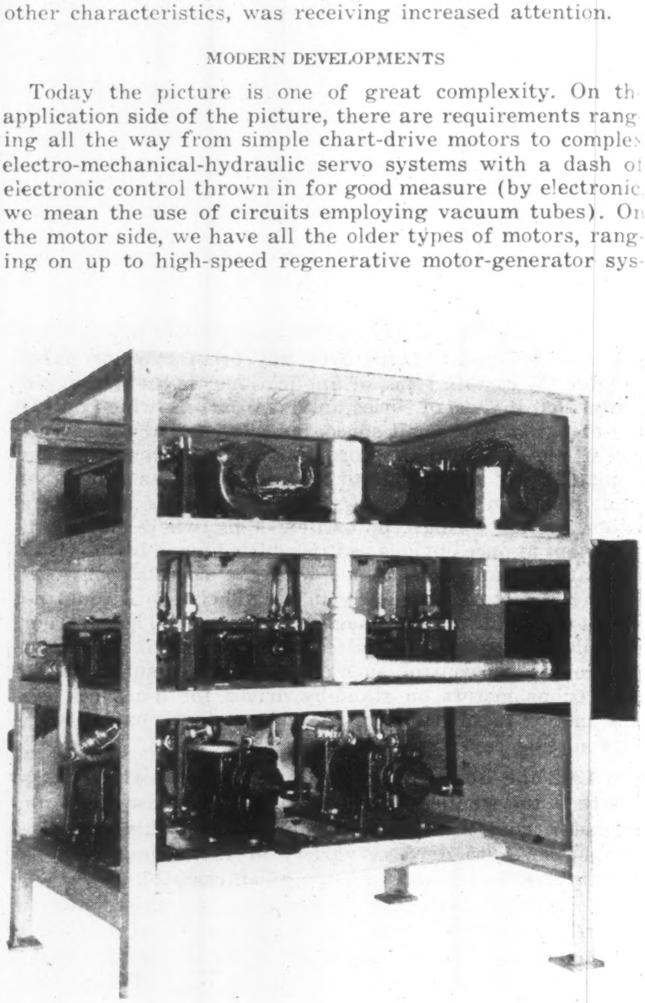
As time went on, this whole field of motor-driven instruments and control apparatus, as well as the motors designed for their operation, expanded considerably. In the field covered by process control, there was an additional requirement for larger motors specially designed for operation of motor-operated valves, proportioning equipment, injector feed units, as well as paper mill, steel mill and other special drives where the problem of speed control, together with other characteristics, was receiving increased attention.



Eagle Signal Corporation. Duraflex timer using hysteresis synchronous motor.

MODERN DEVELOPMENTS

Today the picture is one of great complexity. On the application side of the picture, there are requirements ranging all the way from simple chart-drive motors to complex electro-mechanical-hydraulic servo systems with a dash of electronic control thrown in for good measure (by electronic we mean the use of circuits employing vacuum tubes). On the motor side, we have all the older types of motors, ranging on up to high-speed regenerative motor-generator systems such as the Amplidyne,* and two-phase vacuum-tube controlled high-impedance reversible low-inertia positioning motors.



Askania Regulator Co. Three Selsyn receivers and hydraulic Askania amplifiers which position three cylinders (shown on the lower shelf) directly proportional to the position of three independent Selsyn transmitters not shown in the photograph.

On the one hand, the field of motors and motive power devices as such, and on the other hand the field of instruments and process control apparatus, are completely interdependent. The development of motors is dependent economically on the development of types of apparatus requiring them, while the development of special types of apparatus is dependent engineering-wise on technical developments in the motor and related motor-control field.

THE SPECIALTY MOTOR MANUFACTURER

Many motor manufacturers during this war have been forced into the manufacture of special types of electric iotors. Many of these manufacturers do not want to connue in these specialized fields, but prefer to return to the anufacture of mass-production motors used for such conntionalized purposes as washing machines, refrigerators, l burners, unit heaters, gasoline pump motors, and other ighly-standardized types. Some other manufacturers, rced by the aircraft and armaments program into the anufacture of special types of motors, will not continue fter the reduction in these requirements. There remains, owever, the fact that regardless of what some motor manucturers may do, the various fields of instrumentation—pecially that of process control—have received a greater npetus, both technically and economically, than had ever een experienced in a like period before.

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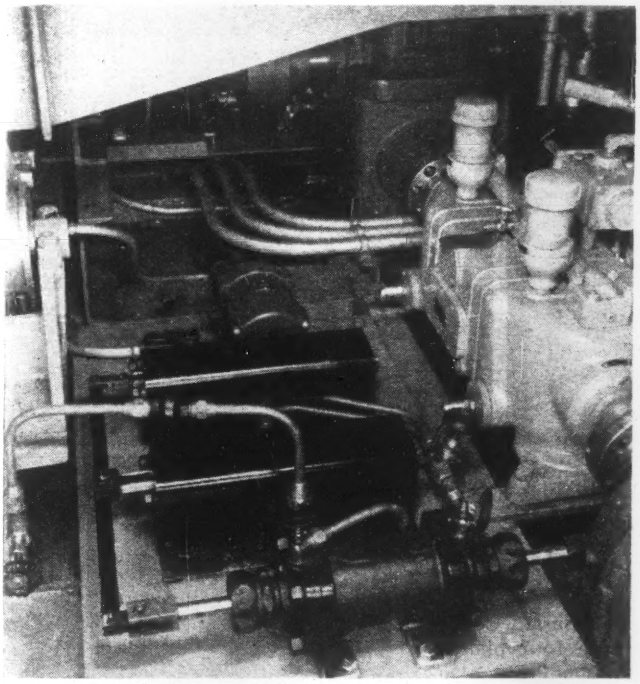
*Editor's Note.—"Amplidyne" is the proprietary name of the rotary-machine power-amplifying system made by the General Electric Company; the one made by the Westinghouse Electric and Manufacturing Co. is called "Rototrol"; the one made by the Allis-Chalmers Manufacturing Co. is called "Regulex." These three differ, of course, not only in design but in operation and applicability, but all are of "large" and "integral" horsepower rating rather than "miniature" or "fractional."—M. F. Behar.

The tremendous emphasis on precision resulting from ie war will not be relinquished. New and better products, ore economically made, resulting from precise measureent and control instrumentation, has taught industry not only to spend more money than ever before on such aids to production, but has pursuaded managers to pay more money than before for such apparatus in order to secure the high degree of precision and quality demanded.

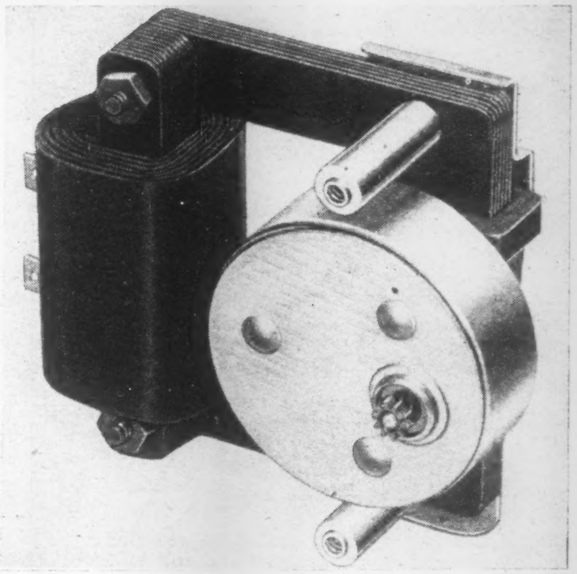


Askania Regulator Co. Receiving end of a Selsyn which operates an Askania hydraulic amplifier and hereby the rate-of-turn of the worm gear (behind hydraulic drive). Can also be used to produce a definite position of the worm gear for every Selsyn position.

These specialty motor manufacturers always have had a rofitable field for their endeavors, and it is without doubt rue that their future activities may exceed all past expectations if they do their part to protect the interests of heir industry by new and effective engineering and merhandising programs.

LOOKING AHEAD

As the war advances, it is highly desirable that some hought should be given to the extended industrial use of re-war developments in these fields, so wonderfully augnented by military requirements. We are not suggesting hat this should take the form of any formal diversion of ur, energies to postwar planning, but it is inescapably ecessary to give some thought to industrial requirements f a non-military nature. We found that while the vast najority of engineers had been far too busy to devote any ime to formal postwar thinking, they were nevertheless sensitive to the desirability of not ignoring it completely. This feeling may naturally be expected to grow in strength as the war draws to a conclusion. It is in furtherance of this feeling that this survey was prepared at this time.



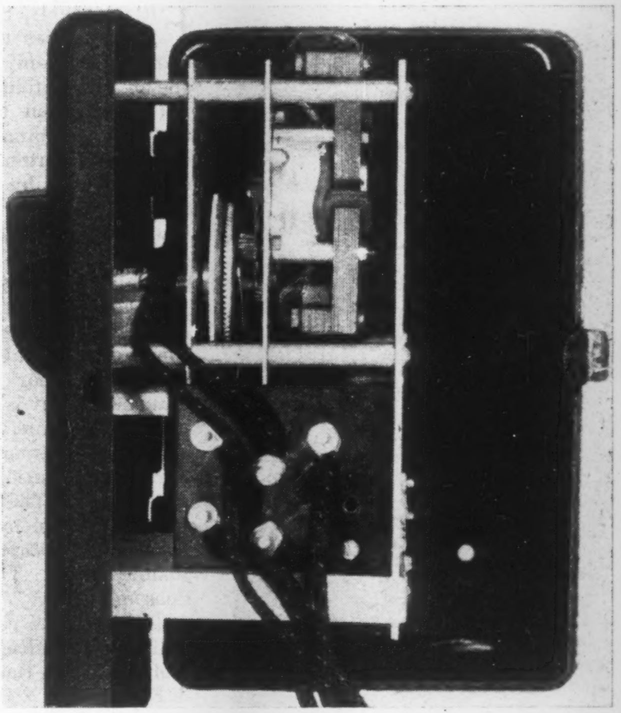
Warren Telechron Type H3 light-duty synchronous gear reducer motor. 2-watt input. Torque 0.018 in.-lb. in one r.p.m.

PLAN OF PRESENTATION

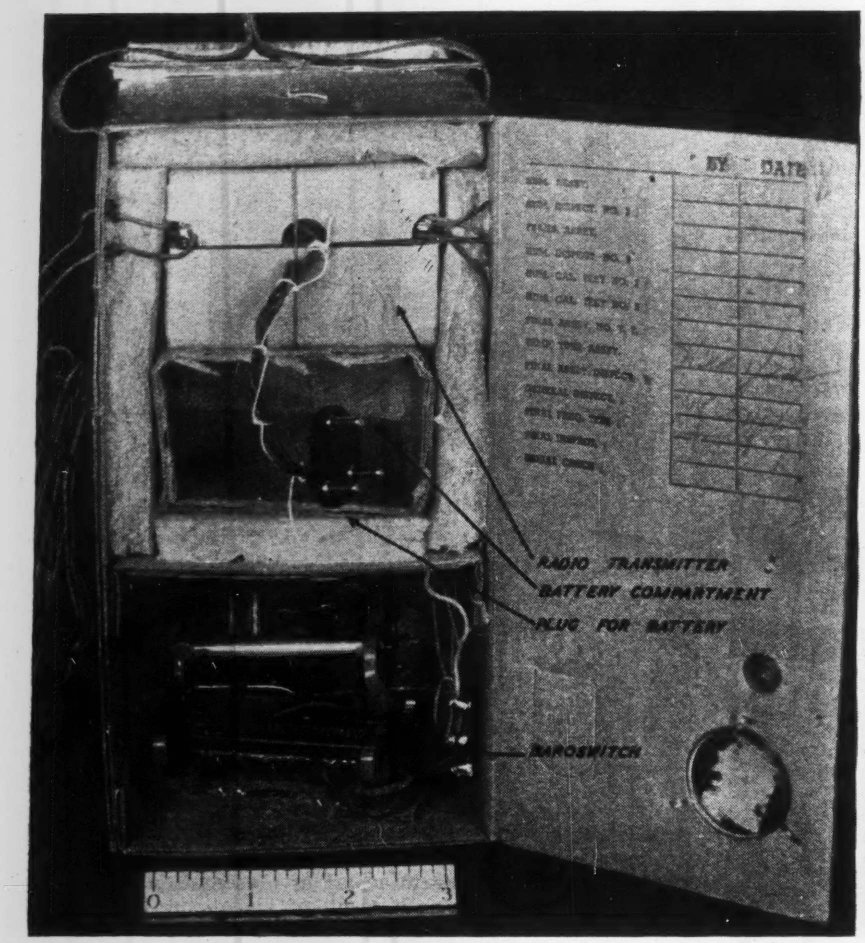
After a thorough analysis of the field of each manufacturer's operations, they were classified and put into associated groups according to a plan of presentation that was gradually crystallized as a result of visualizing the interrelated interests of these groups.

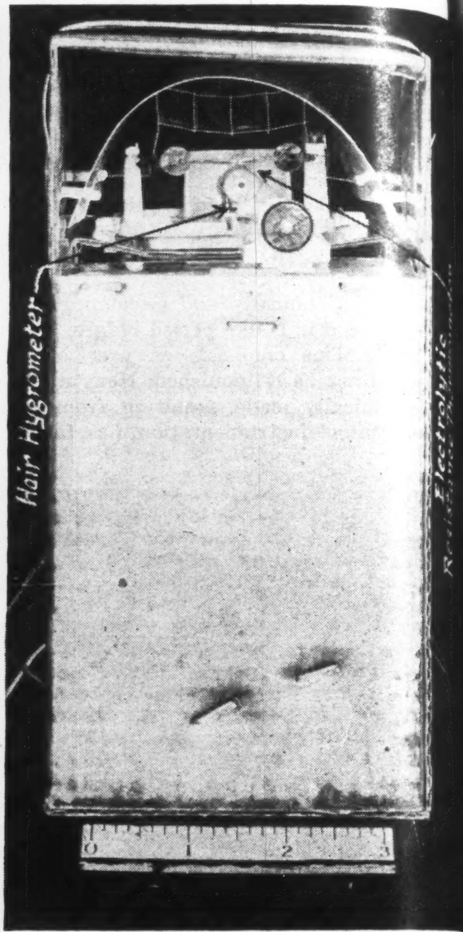
It is very difficult to consider motors without immediately considering the uses to which different kinds of motors are put. This immediately conjures up the picture of a chart, where on one side we list different kinds of motors accord-

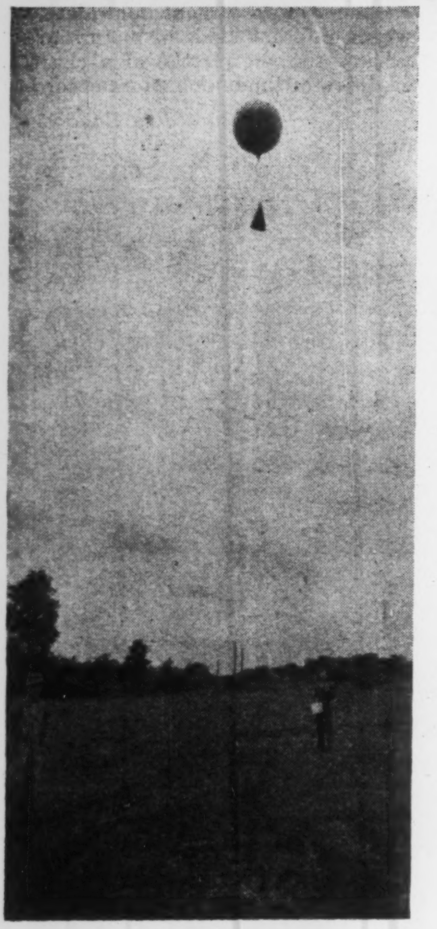
Continued on Page 250



Automatic Electric Mfg. Co. timer using Hansen Mfg. Co. synchronous motor.


BY
DATE
RADIO TRANSMITTER
BATTERY COMPARTMENT
PLUG FOR BATTERY
BAROSWITCH
0
1
2
3


Hair Hygrometer
Electrolytic
Resistance Thermometer
0
1
2
3



U. S. Army's Radiosonde

FROM the U. S. Army's Signal Corps Laboratories come these four photos showing not only a radiosonde but also one of the automatic receptor-recorders.

(*Left*) About to start on its mission, the 3-lb. combination of measuring elements and automatic radio transmitter is being held by the operator. The unmanned balloon will take it aloft to 60,000-ft. altitude or more; the parachute will bring it down to earth after the balloon bursts.

(*Above*) These two pictures have been scaled by *Instruments* to show the radiosonde exactly half actual size. The front view with door open shows the radio transmitter: it is of the audio-frequency modulation type. In the bottom view the resistance element is clearly seen (in horizontal position about 1/16″ above the arrowhead). The individual hairs of the hygrometric element cannot be seen but they are stretched between two easily-visible disks. The barometric capsule does not show.

(*Right*) The receiving equipment, officially called "Radiosonde Receptor AN/FMQ-1 With Radiosonde Recorder RD-3/FMQ-1."

[*For another radiosonde article see Page 266*]

Interconnected Control Instruments[*]

By J. A. PELLETTERE, Chief Instrument Engineer, Pittsburgh Engineering Dep't, Gulf Oil Corp.

NTERCONNECTED instrumentation is in line with today's trend. Too often the Instrument Engineer called upon to answer the question y more than one instrument is re- red to operate a single control valve. hen one studies available literature is surprised to find so little on this bject. The writer sees need and so esents this critical discussion as help guidance for those who work in the ld of Instrumentation.

In order to cover such a subject it ll be necessary to review a little of e fundamentals of control and to show pical diagrams of the common control stallations that the field now has to fer. Under fundamentals, I wish to point out the difference in two common types of instruments being offered the public:

In one type the regenerating mechanism is integral with the band-developing mechanism or throttling-range unit. This type of equipment makes use of a single pilot valve to perform for both the throttling range and regenerating functions. Such instruments are typified by Foxboro, Bristol, Mason-Neilan, Brown and Taylor type units.

The second type of instrument involves a complete, separate regenerating unit with its own pilot valve performing the single function of regeneration and, in most cases, this assembly is mounted externally. The main instrument with its pilot valve merely develops a control band or throttling range. It is interesting to note that the external regenerator can be made to serve many functions other than regeneration. In boiler house instrumentation, both Hagan and Bailey are able to make other uses of this regenerator assembly to perform the function of selectivity, safety limit and the pneumatic setting of one instrument by another.

Some of the disadvantages of the external regenerating unit type of control which are apparent to most instrument men are offset by the many uses to which this unit can be applied. A study of boiler-house instrumentation diagrams will soon convince one that such a system of control has definite advantages in certain applications over the so-called integral regenerating type of control assembly.

Since interconnected instruments are basically ratio instruments, it is appropriate to discuss ratio instruments before going further. The ratio instrument is the first type comprising, by its constructional features, two instruments engaged in a single control function. The definition of the ratio instrument may be roughly as follows:—"A Wild Pen setting up a control action so that the second pen follows the Wild Pen and draws a similar pattern."

The first applications of ratio controllers were flow, and there are two types of ratio flow manometers. In one type, the two manometers are mounted on a single case and there is a ratio linkage provided between the float arms. This might be called a mechanical ratio instrument. The second type consists of a dual pneumatic receiving type instrument where the two elements are 0-15 lbs./in.^{2} (approximately) receiving bellows which can receive air pressure output of transmitters of flow, pressure or temperature as the measured functions. Ratio linkage between these two bellows elements is, of course, a lever system as in the case of the directly-operated lever system of the aforementioned dual manometer.

In Oil Refinery Practice, we seldom admit the presence of a wild stream, the pattern of which we would like to have reproduced by a ratio-controlled stream. Probably the closest approach to this is the case where an accumulator feed tank of small capacity has a rather uneven input flow and we are required to feed, say, a column from this tank and would like to maintain smooth flow of feed to the column. The reflux rate is rationed to the feed meter so that as the level control on the accumulator steps up or slows down the feed rate, the reflux rate follows in proportion.

A good illustration of ratio control is combustion control as applied to the boiler. The demand curve of steam flow from the boiler is basically a wild stream, and all instruments on the boiler are required to function in an effort to maintain good combustion conditions for all demands on the boiler. The combustion controller itself is a ratio controller, fundamentally, with other control features added. In order to maintain

OUTLINE OF PELLETTERE'S CRITICAL DISCUSSION OF INTERCONNECTED CONTROL INSTRUMENTS

Printed in this form as a ***MEMORY-AID*** *at the request of the author*

I. INTRODUCTION

Why more than one instrument is required to operate a single valve.

II. FUNDAMENTALS

(a) Integral Regenerator (Reset)
(b) Separate Regenerator

III. RATIO INSTRUMENTS

(a) Definition
(b) Mechanical Ratio
(c) Pneumatic Ratio
(d) Combustion Control good example of application.

IV. CLASSIFICATION

1. To counteract poor valve or system characteristics.
2. Combat poor reaction curve or reversed impulse.
3. To provide selectivity and/or over-ride.
4. To provide limits without visible stops.
5. To provide safety features.
    (a) Sequence Ratio
    (b) Limits
    (c) Program Timer
    (d) Over-ride:
        (1) Air system in series;
        (2) Dual diaphragm top on valve;
        (3) Limiting relays.
6. To compensate an Important Variable.
    (This usually results in a coarse and fine adjustment and gives anticipatory action.)

V. SUMMARY

(a) Economy *vs.* Controllability in Equipment Design.
(b) System or Valve Characteristic Design considerations, now common.
(c) Present trend.
(d) Discussion of Classification with an alternative offered.

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[*] Substance of a talk before (a) the Phila- lphia Society for Instrumentation on Sept. , 1944, (b) the American Society for easurement and Control on Feb. 26, 1945,) various non-Society groups of instru- ent men; revised exclusively for *Instru- ents*; all drawings made exclusively for *struments*.

good CO_2, the fuel and air flows must follow the demand curve in a very definite pattern.

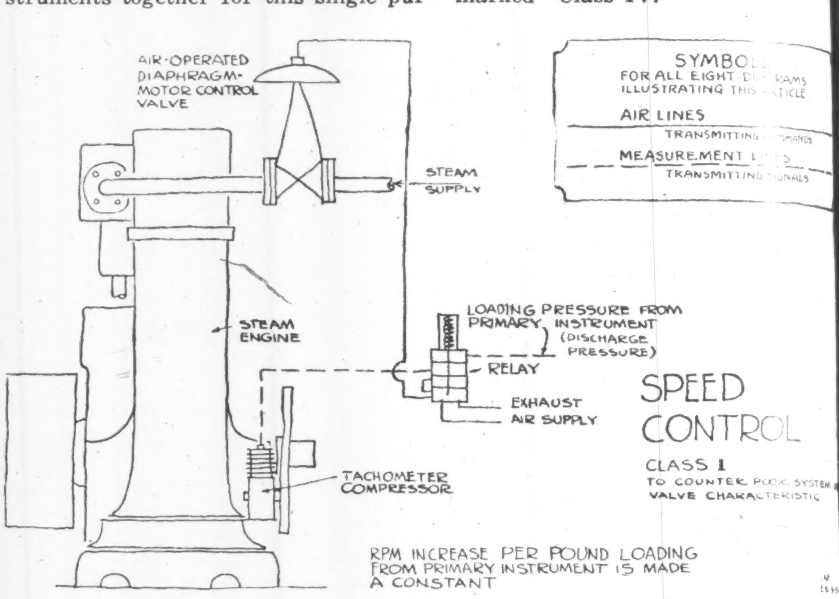
After a long period of observation in connection with school lecturing, I have concluded that there are about six major reasons for connecting together more than one instrument to operate a single control valve.

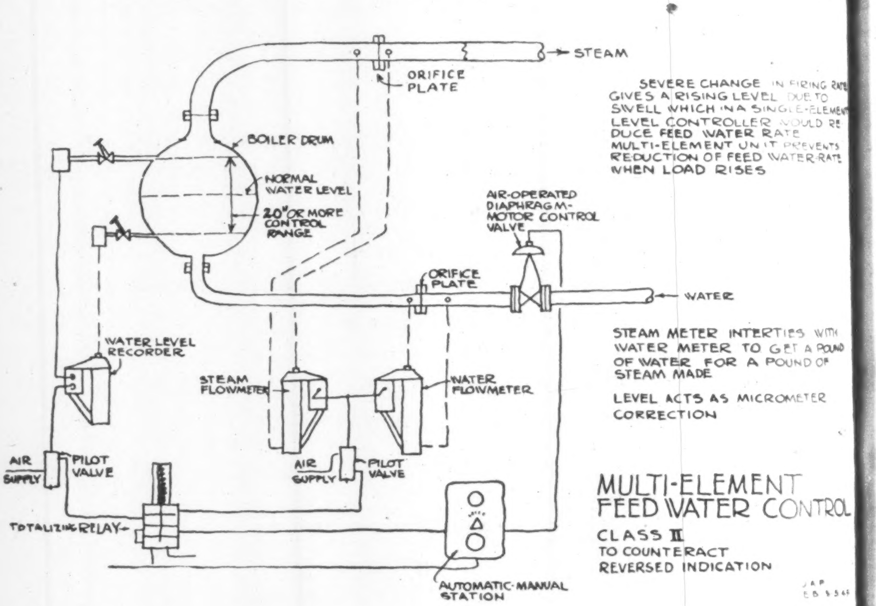
Class I—"Instruments for Counteracting Poor Valve or System Characteristics." When the control instrument such as on boilers, maintaining fuel-air ratio to a boiler, is called upon to move a damper or vanes of a fan, the characteristics of the control valve may be said to be poor. This is obvious since the damper has in most cases a curve similar to a bevel-seated valve. In addition to this, the damper valve is usually the size of the flume and is not a "sized valve" so far as the Instrument Engineer is concerned, flume dimension being prescribed by others. A differential controller is set up to measure pressure-drop across the air heater or boiler setting, and the amount of air is gaged by the differential instrument or airflow meter which is interconnected with the master control instrument. This is an illustration of connecting two instruments together to combat a poor valve characteristic. Another illustration is shown in drawing marked "Class I." (Speed control application.)

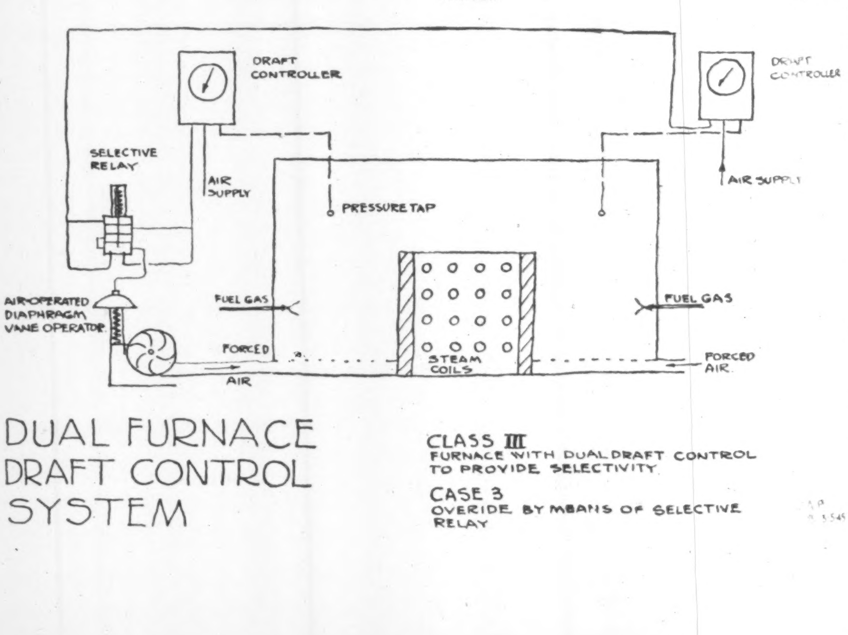
Class II — "Inter-connected Instruments for the purpose of Combating Poor Reaction Curve or Reversed Impulse." The level controller of the single-drum modern boiler classifies in this group. When the load rises sharply and the master control instrument increases the fueling rate rapidly, the level surge in the drum is upward, owing to the specific gravity change of the fluid in the tubes and the fact that the drum capacity is comparatively small. The rise in level under these conditions definitely causes the ordinary level controller to reduce the feed water rate at a time when the steaming rate is rising. The indication or "signal" supplied by the level instruments, for a short period, is in the wrong direction through no fault of the instrument, but owing to the design of the boiler. The figure marked "Class II" illustrates the so-called multi-element boiler level control which interconnects steam meter, feed water meter, and level indicator in order to operate the single feed water valve and to defeat the reversed indication outlined above.

Class III—"Instruments are often Interconnected to provide a Selective or Over-ride Function." Engineers have set up furnace draft control on large furnaces where two instruments measure the draft at different points and are connected through a selector relay so that the one with the highest positive furnace pressure measurement automatically takes over the control function of handling the air input to the furnace. See drawing marked "Class III."

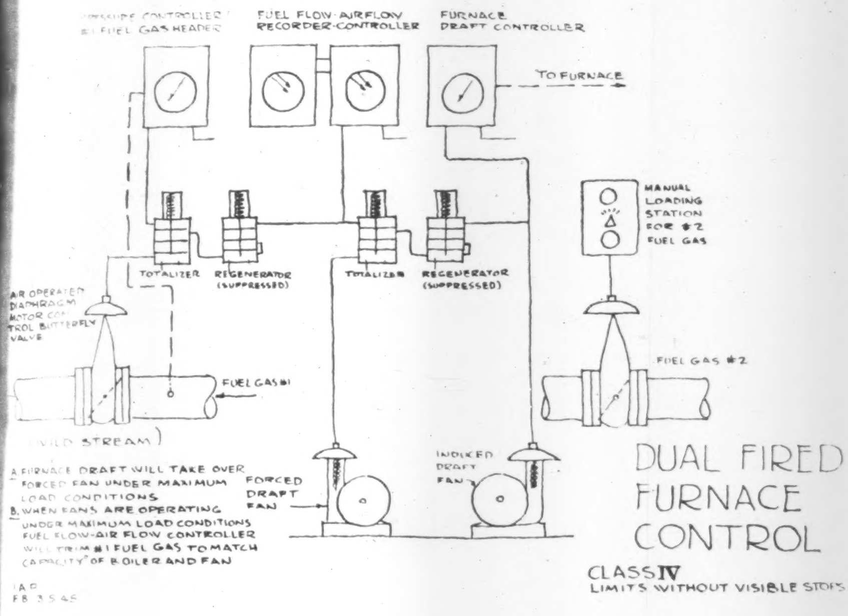
Class IV — "Instruments are Interconnected to provide definite Limits," and to do so without stops being applied to the control valve. It is true that the Instrument Engineer seldom ties instruments together for this single purpose. It also is true that one encounters many complicated diagrams where the Field Engineer demands the use of this feature of limitation of the control action as part of the scheme. See drawing marked "Class IV."


AIR-OPERATED DIAPHRAGM-MOTOR CONTROL VALVE
STEAM SUPPLY
SYMBOLS
FOR ALL EIGHT DIAGRAMS ILLUSTRATING THIS ARTICLE
AIR LINES
TRANSMITTING COMMANDS
MEASUREMENT LINES
TRANSMITTING SIGNALS
STEAM ENGINE
LOADING PRESSURE FROM PRIMARY INSTRUMENT
(DISCHARGE PRESSURE)
RELAY
EXHAUST
AIR SUPPLY
TACHOMETER COMPRESSOR
SPEED CONTROL
CLASS I
TO COUNTER POOR SYSTEM OR VALVE CHARACTERISTIC
RPM INCREASE PER POUND LOADING FROM PRIMARY INSTRUMENT IS MADE A CONSTANT


STEAM
ORIFICE PLATE
BOILER DRUM
NORMAL WATER LEVEL
20" OR MORE CONTROL RANGE
SEVERE CHANGE IN FIRING RATE GIVES A RISING LEVEL DUE TO SWELL WHICH IN A SINGLE-ELEMENT LEVEL CONTROLLER WOULD REDUCE FEED WATER RATE
MULTI-ELEMENT UNIT PREVENTS REDUCTION OF FEED WATER RATE WHEN LOAD RISES
AIR-OPERATED DIAPHRAGM-MOTOR CONTROL VALVE
ORIFICE PLATE
WATER
WATER LEVEL RECORDER
STEAM FLOWMETER
WATER FLOWMETER
STEAM METER INTERTIES WITH WATER METER TO GET A POUND OF WATER FOR A POUND OF STEAM MADE
LEVEL ACTS AS MICROMETER CORRECTION
AIR SUPPLY
PILOT VALVE
AIR SUPPLY
PILOT VALVE
TOTALIZING RELAY
AUTOMATIC-MANUAL STATION
MULTI-ELEMENT FEED WATER CONTROL
CLASS II
TO COUNTERACT REVERSED INDICATION
J.A.P.
F.B. 3.5.45


DRAFT CONTROLLER
DRAFT CONTROLLER
SELECTIVE RELAY
AIR SUPPLY
PRESSURE TAP
AIR SUPPLY
AIR-OPERATED DIAPHRAGM VANE OPERATOR
FUEL GAS
FUEL GAS
FORCED AIR
STEAM COILS
FORCED AIR
DUAL FURNACE DRAFT CONTROL SYSTEM
CLASS III
FURNACE WITH DUAL DRAFT CONTROL TO PROVIDE SELECTIVITY
CASE 3
OVERIDE BY MEANS OF SELECTIVE RELAY
J.A.P.
F.B. 3.5.45

Class V—"Instruments are Interconnected to provide Safety Features." This classification may include some of the classes already listed. Safety features may employ over-ride protection, limits, program timer, and sequence ratio instrumentation. The safety feature may include many of the above-mentioned applications in one diagram. Some people may think the program timer should have a classification all its own because timing does not necessarily involve danger in the event of failure; however, I prefer to let the program timer be a part of "Class V—Safety Feature" Division. See drawing marked "Class V" which illustrates sequence ratio safety instrumentation.

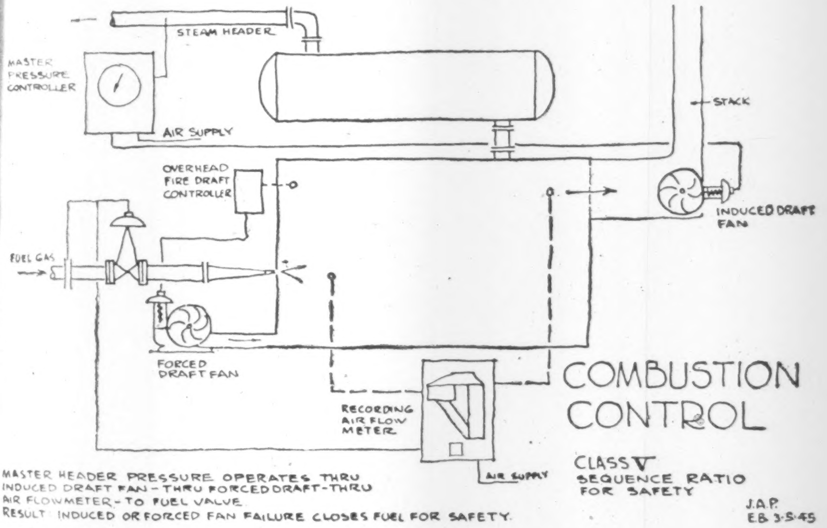

PRESSURE CONTROLLER #1 FUEL GAS HEADER
FUEL FLOW-AIRFLOW RECORDER-CONTROLLER
FURNACE DRAFT CONTROLLER
TO FURNACE
MANUAL LOADING STATION FOR #2 FUEL GAS
TOTALIZER
REGENERATOR (SUPPRESSED)
TOTALIZER
REGENERATOR (SUPPRESSED)
AIR OPERATED DIAPHRAGM MOTOR CONTROL BUTTERFLY VALVE
FUEL GAS #1
FUEL GAS #2
WILD STREAM)
FORCED DRAFT FAN
INDUCED DRAFT FAN

A. FURNACE DRAFT WILL TAKE OVER FORCED FAN UNDER MAXIMUM LOAD CONDITIONS
B. WHEN FANS ARE OPERATING UNDER MAXIMUM LOAD CONDITIONS FUEL FLOW-AIR FLOW CONTROLLER WILL TRIM #1 FUEL GAS TO MATCH CAPACITY OF BOILER AND FAN

J.A.P.
EB 3.5.45

DUAL FIRED FURNACE CONTROL

CLASS IV
LIMITS WITHOUT VISIBLE STOPS

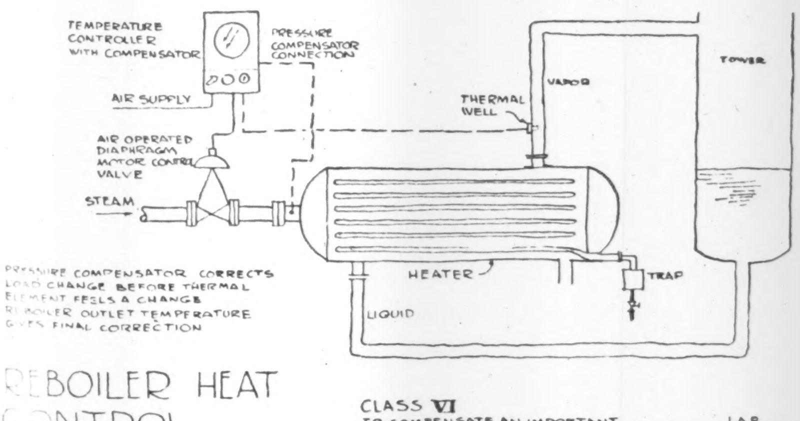

STEAM HEADER
MASTER PRESSURE CONTROLLER
AIR SUPPLY
STACK
OVERHEAD FIRE DRAFT CONTROLLER
INDUCED DRAFT FAN
FUEL GAS
FORCED DRAFT FAN
RECORDING AIR FLOW METER
AIR SUPPLY

COMBUSTION CONTROL

CLASS V
SEQUENCE RATIO FOR SAFETY

MASTER HEADER PRESSURE OPERATES THRU INDUCED DRAFT FAN—THRU FORCED DRAFT—THRU AIR FLOWMETER—TO FUEL VALVE
RESULT: INDUCED OR FORCED FAN FAILURE CLOSES FUEL FOR SAFETY.

J.A.P.
EB 3.5.45


TEMPERATURE CONTROLLER WITH COMPENSATOR
PRESSURE COMPENSATOR CONNECTION
AIR SUPPLY
AIR OPERATED DIAPHRAGM MOTOR CONTROL VALVE
STEAM
THERMAL WELL
VAPOR
TOWER
HEATER
TRAP
LIQUID

PRESSURE COMPENSATOR CORRECTS LOAD CHANGE BEFORE THERMAL ELEMENT FEELS A CHANGE
REBOILER OUTLET TEMPERATURE GIVES FINAL CORRECTION

REBOILER HEAT CONTROL

CLASS VI
TO COMPENSATE AN IMPORTANT VARIABLE

J.A.P.
EB 3.5.45

Class VI—"Interconnected Instruments to compensate an important Variable." This is today's trend. The result of such interconnection usually brings about a coarse and fine adjustment and does have anticipatory characteristics in that the coarse adjustment is applied before the main instrument has felt a change, the fine adjustment being made by the main instrument. The drawing marked "Class VI" shows such an arrangement: basically, reboiler pressure is interconnected with reboiler temperature to operate the heating valve to the reboiler. Since pressure changes upon change of load in the reboiler even before the temperature has started to change, it applies the first correction to the control valve, and then the primary temperature instrument applies the fine correction, in a diagram of this sort.

TYPES OF OVER-RIDE

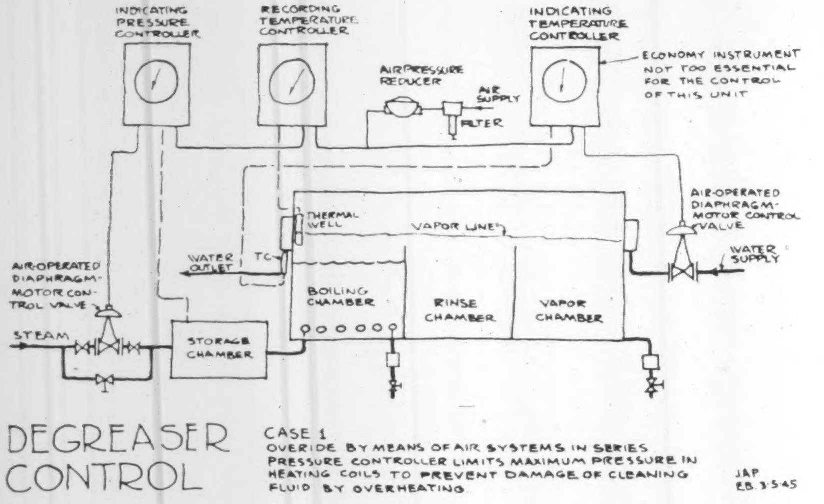
Today's instrumentation involves a lot of automatic trip-out devices which may or may not require manual resetting. Many of these mechanisms consist of electrical contacts operating a solenoid valve to shut down a piece of equipment when a point of dangerous operation has been reached. These gadgets are not being included under the heading of "Over-ride Instrumentation." I am confining Over-ride to secondary instruments which take over the control problem when a predetermined point is reached. This type of interchange of the control mechanism from one instrument to another may be called "Selective Control" or "Over-ride Control."

The more common methods for Override Control are three in number:

In the first case the air output of a given controller is allowed to pass through another controller which is adjusted to a point of danger (maximum or minimum). In the event that the second instrument attains its reading before the first instrument is satisfied, the second instrument acts as a modulator and interrupts or reduces the air to the control valve, maintaining the control point as that point to which the second instrument has been set. The drawing marked "Case I" shows degreaser control which illustrates this point.

In the second case, use is made of the dual diaphragm top for control valve, set up so that the over-ride instrument takes over the valve by overcoming the air pressure in the primary diaphragm. The primary instrument in this case is energizing one of the diaphragms, and the secondary instrument usually is set up so that no pressure is applied to its diaphragm until the emergency arises, when the second instrument will supply sufficient air pressure to its diaphragm member to overcome the primary diaphragm and take over the control valve. The drawing marked "Case 2" illustrates this point.

In the third case, over-ride is attained by the secondary instrument working through a relay to interrupt the diaphragm line between the primary instrument and the control valve. These


INDICATING PRESSURE CONTROLLER
RECORDING TEMPERATURE CONTROLLER
INDICATING TEMPERATURE CONTROLLER
ECONOMY INSTRUMENT NOT TOO ESSENTIAL FOR THE CONTROL OF THIS UNIT
AIR PRESSURE REDUCER
AIR SUPPLY
FILTER
AIR-OPERATED DIAPHRAGM-MOTOR CONTROL VALVE
THERMAL WELL
VAPOR LINE
WATER OUTLET
TC
WATER SUPPLY
AIR-OPERATED DIAPHRAGM-MOTOR CONTROL VALVE
BOILING CHAMBER
RINSE CHAMBER
VAPOR CHAMBER
STEAM
STORAGE CHAMBER
JAP
EB. 3-5-45

DEGREASER CONTROL

CASE 1
OVERIDE BY MEANS OF AIR SYSTEMS IN SERIES
PRESSURE CONTROLLER LIMITS MAXIMUM PRESSURE IN HEATING COILS TO PREVENT DAMAGE OF CLEANING FLUID BY OVERHEATING

interconnected relay over-ride members are becoming more common, but for the most part usually result in a cutoff action rather than assuming of control by the second instrument. The drawing marked "Class III" also illustrates "Case 3—Limiting Relay."

Today, with the trend toward economical construction, the instrument control problem often becomes harder as equipment becomes smaller and cheaper. This is definitely illustrated in today's modern boiler where the generation per dollar and the pounds of steel per pound of steam generated have moved in opposite directions. The result of such economical design is leading to interconnection of instruments to overcome some of the hardships imposed on the instruments by such design.

The Instrument Engineer has slowly learned to recognize that where the control valve, through its fault or through system faults, has a poor characteristic, it is necessary to interconnect instrumentation in order to overcome these defects. This is illustrated in the control of air flow through the boiler where one is required to measure differential pressure drop and reset the air flow, rather than expect damper characteristics to maintain a flat CO_2 curve.

The present-day trend is in accordance with "Class VI," which is to compensate an important variable which cannot be made a constant. In many cases the main controller is slow to react to changes in the system by reason of the many lags the instrument must encounter. This is especially true in the field of temperature control. It has become necessary, in this type of problem, for the Instrument Engineer to make use of some variable which responds to the load change more readily than the main control point. In order to do this, the variable must be measured and a signal taken from a measurement of the variable and fed into the control system.

A good illustration of the above is where an automatic fireman is applied to the fired coil heater, with the throughput in the heating coil necessarily undergoing changes from time to time. In order to fire any such equipment where the throughput through the coil cannot be made a constant, the problem can be helped considerably by measuring with an orifice the flow through the coil and feeding a signal into the control system from this orifice, to make corrections immediately upon change of flow rather than to wait for the outlet thermocouple to pick up these fluctuations. In a problem like this, the outlet pyrometer controller and the flowmeter are interconnected, in order to operate the single control valve installed in the fuel line.

Another illustration of this Class VI application is the case where a differential temperature, measured near the top of a column involving many trays, is set up to control the heat to the reboiler at the base of the column. When the differential temperatures in the top of the column begin to show a change (usually a sign of change in composition of the overhead mixture), it is entirely too late to begin to apply correction to the reboiler heat, as the many trays in the bottom section of the column are now operating under a new equilibrium. Such a control system, on change of load or feed rate to the column, involves serious delay between the time of load change and the time th the differential temperature elemen respond to the situation. Such an strument as this can be considerab helped by measuring, by means of orifice, the feed rate (which admitted is not a straight line in this case) an interconnecting the differential the mometer with the feed rate orifice such a manner as to obtain an immed ate correction of the load change rathe than to wait for the whole column go off test, at which time the differenti instrument would recognize the fa but, unfortunately, too late.

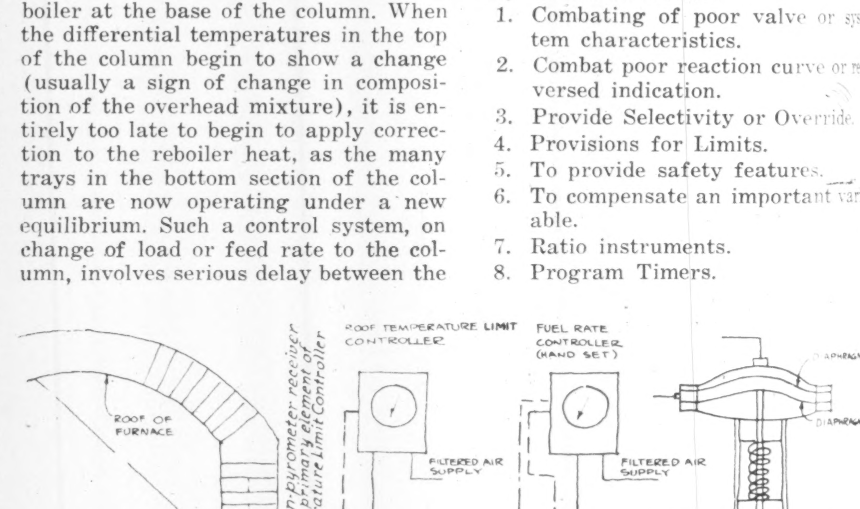
"Class I—To Counteract Poor Valv Characteristics" and "Class VI—Com pensation of an Important Variable are today's main points in new dia grams being developed. The engineer slowly learning to incorporate these tw ideas in the control diagram.

"Class IV — to Provide Limitation without Visible Stops," is also becom ing a common tool of the design eng neer. Most diagrams of control system show limits as a part of the pictur and, in most cases, they involve ver little in extra costs.

Catalytic cracking or treating units make extensive use of "Class V—Se quence or Program Timers," with safety interlock, along with many of the other classes.

A study of the six classes outlined may cause one to comment that Program Timers should have a classification group of their own, and that the simple ratio instruments should have a classification of their own. To please those who feel that these two classes have been poorly treated, I am listing a second group of classifications which may be more suitable:

1. Combating of poor valve or system characteristics.
2. Combat poor reaction curve or reversed indication.
3. Provide Selectivity or Override.
4. Provisions for Limits.
5. To provide safety features.
6. To compensate an important variable.
7. Ratio instruments.
8. Program Timers.


ROOF OF FURNACE
Radiation-pyrometer receiver serving as primary element of Roof-temperature Limit Controller
ROOF TEMPERATURE LIMIT CONTROLLER
FUEL RATE CONTROLLER (HAND SET)
FILTERED AIR SUPPLY
FILTERED AIR SUPPLY
DIAPHRAGM
DIAPHRAGM
DIAGRAMMATIC OF DUAL DIAPHRAGM TOP
DUAL DIAPHRAGM AIR OPERATED CONTROL VALVE
ORIFICE PLATE
FUEL
TO COMBUSTION CHAMBER
JAP
EB 3-5-45

When temperature of furnace roof reaches pre-set limit, fuel valve responds to roof temperature limit controller, which overrides fuel-rate controller

HEARTH CONTROL

CASE 2
OVERIDE USING DUAL DIAPHRAGM VALVE

ELECTRIC GAGING METHODS for Strain, Movement, Pressure and Vibration

By **HOWARD C. ROBERTS**, Research Staff, Association of American Railroads, Chicago, Ill.

VIII. THERMOELECTRIC, ACOUSTIC, AND OTHER METHODS.

§ 1. THERMOELECTRIC METHODS.

If in an electric circuit of metallic conductors a difference in temperature occurs between different portions of the circuit, there will be in general electric potentials produced. If the circuit is completed, current will flow as a consequence of the difference of potential. Since their origin is in a temperature difference, these potentials are called thermoelectric.[284]

The potential available for measurement in such a circuit is the algebraic sum of the several electromotive forces present. These emf's result from two basic phenomena: the Peltier effect and the Thomson effect. Peltier emf's are those occurring at junctions of dissimilar metals and are proportional in magnitude to the absolute temperature at the junction. Thomson emf's are developed along conductors where thermal gradients exist, and the law describing their production and magnitude has not been precisely formulated. The total utilizable thermoelectric potential in a circuit—sometimes called the Seebeck emf.—is the resultant of these two electromotive forces.*

In a closed electric circuit it is manifest that there must be more than one junction of dissimilar metals, and the limitations of measuring equipment require the use of a closed circuit. It may be said, therefore, that the simple thermoelectric circuit must contain two (or more) junctions of dissimilar metals and some instrument for measuring the potential produced. This measuring instrument may be a potentiometer (the most desirable instrument) or a millivoltmeter. Actually, the millivoltmeter is a current-actuated instrument, but the current flowing is proportional to the potential produced so long as the resistance of the circuit remains constant. In order to minimize changes in circuit resistance, it is common practice to install a high-resistance instrument (or a series resistor) having a nearly-zero temperature coefficient of resistance. The potentials involved are small—only a few millivolts—so the current is limited to small values by the circuit resistance.

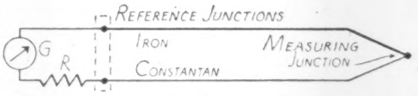


FIG. 125

Such a circuit is illustrated in Fig. 125, where a junction of iron and constantan is exposed to a temperature T_1, while the rest of the circuit remains at a temperature T_2. It is a characteristic of thermoelectric circuits that a conductor of a different metal may be added to the circuit at any time without changing the total thermoelectric potential present, if both ends of the added conductor are at the same temperature. Thus the presence of the instrument G and the resistor R do not introduce new thermoelectric emf's.

This characteristic of the thermoelectric circuit is applied in the contact thermocouple, which is sometimes used for the measurement of surface temperature of clean metal parts, and sometimes for the measurement of temperature of molten metal which rapidly destroys the thermoelectric metals. If electrodes of two dissimilar metals are brought into contact with a clean metal surface—as in Fig. 126—they will constitute (effectively) one "hot" junction and a thermoelectric potential will be produced. The magnitude of the potential appearing at the instrument will indicate the difference in potential between the "hot" and the "cold" junction—the measuring instrument. Unless care is exercised in its application, the contact thermocouple may produce large errors because of contamination of the junctions and large changes in circuit resistance.

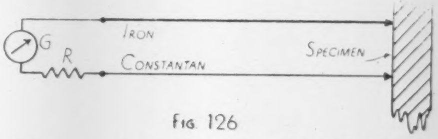


FIG. 126

An extremely convenient method for shop testing and classification of metals depends upon their thermoelectric properties.[285] If a standard piece is pressed into contact with the unknown piece and the point of contact then heated locally by passing an electric current through the junction, thermal emf's can be detected when the heating current is interrupted, if the pieces differ in composition. The method is applicable to most metals, either in a structure or as separate specimens; the electric circuits employed may contain many metals. The test (the Identometer) is rapid and inexpensive.

Conversion of other magnitudes into temperature values, so that they may be measured with thermoelectric elements, is possible only in certain instances. Electric current is perhaps most easily measured of all. It is only necessary to pass the current through a resistance element, measuring the resulting increase in temperature with a thermoelectric circuit. Fig. 127 illustrates some forms of such elements. For some applications the simple uninsulated junction shown at Fig. 127A is satisfactory, it can be constructed simply by crossing two wires of different materials and welding or hard-soldering the junction. Current introduced at A-A heats the junction, while the resultant electromotive force is measured at B-B. If it is necessary to isolate the current from the measuring circuit, the heating element and the thermal junction may be separated by an air space, or both imbedded in an insulating bead, as drawn in Fig. 127B. For the highest current sensitivity, a multiple-junction element is frequently used, especially in thermocouple-type radio-frequency current meters. The general form of this element is shown in Fig. 127C. A number of thermal junctions are connected in series as shown, alternate "hot" junctions being exposed to the heater element, while a radiating member keeps the "cold" junctions at room temperature. This type of assembly, when arranged so that radiant en-

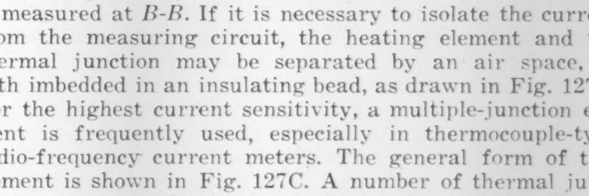


FIG. 127

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(284) M. F. Behar. Thermoelectric Pyrometry. *Instruments*, Vol. 13, 1940, pages 296, 298, 300-320.

*These phenomena are reversible. The direct effect is the production of an electromotive force from a difference in temperature; the converse is the production of heat by the passage of a current. This must not be confused with the Joule production of heat (the I^2R relation); current flowing in one direction through a Peltier junction heats it while current flowing in the other direction cools the junction.

Transfer of heat by this means is extremely inefficient, however; for example, it is not practicable to install a thermocouple in the exhaust-pipe of an automobile and produce enough current to light the headlamps.

(285) Anon. New Instrument for Alloy Check-Analyses. *Iron Age*, Vol. 36, Jan. 15, 1942, pages 36, 95.

ergy can impinge upon one set of junctions while the other set is shielded, is called a thermopile, and is employed in radiation pyrometers and similar devices.

For the higher sensitivities—the lower ranges of current—the thermal elements are often encased in evacuated glass bulbs, so that their temperatures are not disturbed by random air currents, and to equalize the dissipation of heat from the current-carrying element. The very highest current sensitivity is obtained with the Duddell thermo-galvanometer, where the thermal junction is attached to the suspended coil of a sensitive D'Arsonval galvanometer, and heat is introduced by a stationary heating element, not attached in any way to the moving coil.

All these thermal elements respond to the effective value of the current flowing, so that they may be used for measuring either direct or alternating current, at low or at high frequencies. Their principal application is in the measurement of high-frequency currents or currents of varying frequency.

A special form of the thermoelectric current-measuring element is the thermocell, used occasionally to replace the standard cell in portable galvanometers. Since the heat produced by an electric current increases as the square of the current, and certain combinations of metals used as thermocouple materials show a highly non-linear potential-versus-temperature curve, it is possible to select one current value which may be determined to a high degree of accuracy by the thermocell. Its advantages are light weight and ruggedness; it is not nearly so accurate a device as the standard cell.

The rate of heat dissipation—and therefore the temperature—from an element carrying a constant electric current depends upon the pressure, velocity, and composition of the medium in which it is suspended. Gas pressures thus can be measured with a sensitive thermal element, simply by applying a constant current and measuring the electromotive force produced.[286] Velocities of gas flow may be measured similarly, although greater accuracy is obtained from a composite element, such as that diagrammed in Fig. 128, in which both "hot" and "cold" junctions are placed within the airstream and are cooled by it, while one of them is heated by the passage of a known current.[287]

Velocities of liquid flow are more accurately measured by thermoelectric elements if the sensitive element is employed to measure the temperature (or the rate of cooling) of a solid suspended within the liquid.[288,289] Such an indirect method can sometimes be applied to an object already present in the apparatus, so that it is not necessary to introduce a new obstruction into the stream. Analyses of the effect of immersed obstructions, and of their rates of cooling, are available.[290] Ordinarily, however, experimental calibrations are made.

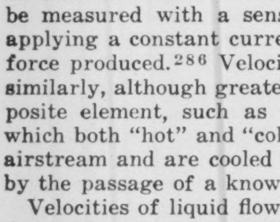

FIG. 128A

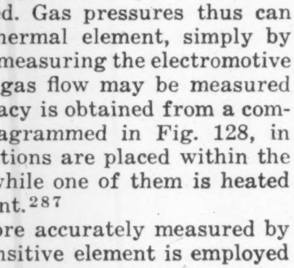

FIG. 128B

In order to make thermoelectric elements sensitive to direction, rather than velocity, or fluid flow, it has been found practicable to install a pair of thermoelectric junctions at the ends of a short tube with a small heating element at its center, as indicated in Fig. 129. When such an assembly is placed with its axis perpendicular to the airstream, there is no flow of air through the tube, but if it is tilted in either direction some air will flow through the tube, carrying heat to one or the other of the thermal junctions.[291] The indication appearing at the galvanometer, therefore, will represent the angle and the rate of air flow. Consequently, the device is qualitative, used to establish the direction of the flow of air (or other fluid), and requires no calibration.

Another mechanical modification which gives a thermoelectric element a discriminatory characteristic is the thermal-lag sleeve used with the so-called "anticipatory thermocouple." This element (really a dual element) is composed of two thermal junctions connected back-to-back, so that the two wires leading to the instrument are of the same material. One junction is incased in a sleeve which adds considerably to its thermal capacity and reduces greatly its speed of response. When both these "hot" junctions are at the same temperature, no electromotive force appears at the indicating instrument. But as the temperature changes, the thermally-insulated junction cannot follow the temperature change as rapidly as does the bare one, and an electrical output is produced, representing, in magnitude and polarity, the rate of change, and the direction of change, of the temperature being observed.

There have been few successful applications of thermal elements to the measurement of movements, strains, or vibrations. They have had some application as telemetering devices[293] and as relays, and there was at least one successful follow-up system (Cambridge, now discontinued) in which a thermal junction was employed as a sensing element to detect the movement of an instrument pointer. In general, however, thermoelectric elements are not readily applicable to measurement of mechanical magnitudes, excepting in the particular instances described.

The thermoelastic effect, a phenomenon akin to the Thomson effect, consists in the production of an electric potential between two points on a metallic specimen when an elastic deformation occurs while they are at different temperatures.[294,295] The emf. produced varies both with the difference in temperature and with the stress intensity. In its present stage of development the thermoelastic method is not capable of either high sensitivity or a high order of accuracy, but occasionally it can be effectively applied. The essentials of the method are diagrammed in Fig. 129, in which the specimen is considered as subjected to a cyclically varying stress, while two electrical contacts are applied to the stressed portion with one of them artificially maintained at a higher temperature than the other. The current output obtained from this electrode assembly is passed through a high-ratio transformer, so that any steady thermoelectric currents will be eliminated from the output, and the remaining signal is amplified and recorded.

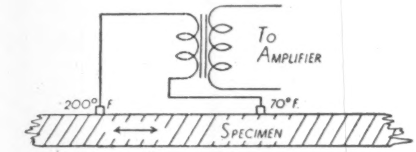

FIG 129

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(286) G. C. Dunlap. Thermocouple Gage for Vacuum Measurement. *Review of Scientific Instruments*, Vol. 8, 1937, pages 37, 38.

(287) E. A. Yunker. An Air-Speed Indicator. *Review of Scientific Instruments*, Vol. 10, 1939, page 317.

(288) C. J. Fechheimer and E. L. Harder. Hot-sphere Anemometer. *Electrical Journal*, Vol. 27, 1930, page 536.

(289) R. A. Saban, W. H. Hillendahl, E. J. Gallegher, and A. L. London. A Thermal Anemometer for Low-Velocity Flow. *Transactions American Institute of Mechanical Engineers*, Vol. 65, 1943, pages 843-846.

(290) M. J. Boussinesq. Sur le pouvoir refroidissant d'un courant liquide ou gazeux. *Comptes Rendus de l'Academie des Sciences*, Vol. 133, 1901, pages 257-265.

(291) L. S. O'Bannon. A New Method of Determining Fluid-current Direction and Making Circulation Surveys. *Instruments*, Vol. 17, 1944, pages 740, 777, 778.

(292) R. L. Longini. Anticipating Thermocouples for Close Temperature Control. *Product Engineering*, Vol. 15, Jan. 1944, page 49.

(293) P. M. Lincoln. Totalizing of Electric System Loads. *Transactions American Institute of Electrical Engineers*, Vol. 48, 1929, pages 775-782.

(293a) P. A. Borden and M. F. Behar. Telemetering and Totalizing. Thermal Position-type System. *Instruments*, Vol. 8, 1935, pages 256-260.

(294) F. Lichtenberger. Thermoelastische Spannungsmessung. *Archiv fuer Technisches Messen*, No. 119, May 1941, pages T 62-64.

(295) F. Lichtenberger. Einwirkung elastischer Spannungen auf die Thermokraefte. *Luftfahrtforschung*, Vol. 14, 1937, pages 26-35.

Of the methods just described, only those used for measurement of temperature and of electric current flow have been widely used. All deserve careful consideration, however, because in the application of electric gaging circuits of high sensitivity, thermoelectric effects often appear as sources of error. An appreciation of this fact will often point the way to correct an improper installation. One of the most useful descriptions of such circuits, and discussion of possible sources of error, appears in the first reference,[284] which supplies many details for which there was not room here.

§ 2. ACOUSTIC METHODS.

A method which should perhaps be termed quasi-electrical, since in it electric circuits are employed only for convenience and for transmission and analysis of data, is that which employs the acoustic or vibrating-wire gage. Although a number of difficulties appear in its application, the device is in principle very simple, and is capable of high sensitivity. It consists merely of a taut wire, stretched over bridges mounted in such a manner that the strain (or other magnitude) being measured alters the tension in the wire and therefore its natural frequency. One form of such assembly is illustrated in Fig. 130; the wire is of steel and is stretched over bridges attached to a specimen which is to experience changes in length. The natural frequency of vibration of the wire is measured by exciting it with the variable-frequency oscillator and the magnetic driving unit; resonance is indicated by the output meter. From the change in natural frequency of the wire the change in tension, and therefore the change in length, can readily be computed.[296,297]

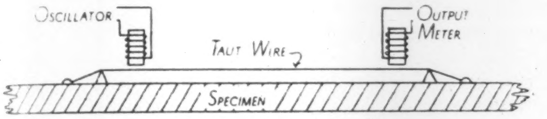

FIG. 130

In the application of vibrating-wire gages precautions must be taken to insure that the change in frequency of the wire is the result of a change in length only; a change in temperature can also produce a change in tension. Error from this source can be evaluated and eliminated by the use of a reference unit placed close to the operative unit —or, conversely, the assembly can be used as a temperature-sensitive device.[298]

One form of the vibrating-wire strain gage is so constructed as to permit most of the steady tension of the wire to be balanced by a spring element, instead of requiring the specimen and the gage mounting to support both the mass of the gage and the tension in the stretched wire.[299] The sensitivity of the gage—already quite high—may be further increased in this form, and the gage can then be used on soft or friable materals, such as stone, wood, or plastic. The base-length of this type of gage may be made as large as desired, or as small as an inch or a little less. Vibrating-wire gages have been used to measure torque,[300] strain,[296] temperature[298] and pressure.[301]

Certain other devices ordinarily considered acoustic—the capacitor transmitter, the moving-conductor microphone and seismometer, the hot-wire microphone, and some of the piezoelectric devices—have already been described under classifications more closely fitting their mode of operation.

§ 3. OTHER METHODS.

The use of contact-closing devices operated by acceleration forces—as distinguished from those operated by displacement, and constituting another form of variable-resistance element—provides a simple, robust, and widely applicable method for detecting the presence of accelerations greater than some predetermined value. An object resting unattached upon a horizontal surface will remain in contact with that surface so long as the vertical vibrational acceleration is less than the acceleration of gravity; higher acceleration values will produce a separation between the object and the surface on which it rests, and an electric circuit can be broken by the separation. If the force maintaining the contact is increased by a spring suspension, a higher value of acceleration will be required to break the circuit, and a series of such contacts can be set up to indicate as many different values of acceleration as it is desired to record.[302] When elastic forces rather than the force of gravity are employed, the device can be made sensitive to accelerations in directions other than vertical. By proper design of the spring-loaded contacts the accelerations accompanying movements of quite small amplitude—such as those of vibrating diaphragms—can be evaluated.[303] A system which can be applied to this sort of measurement is sketched in Fig. 131, and with it an electric circuit so devised that the neon-bulb indicator remains dark until the contact is broken, but when once lighted is not extinguished when the contact is re-established. This behavior is afforded by the resistance network shown; so long as the contacts are closed the potential drop across the neon bulb is not great enough to cause the glow discharge to begin (which requires about 95 volts) but is sufficient to maintain the discharge (about 70 volts) after the momentary increase has initiated it. This circuit is easily applicable to peak-value measurements as well as to the use described here.

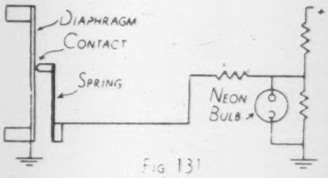

FIG 131

Another method, somewhat similar to the contact-breaking accelerometer, employs a drop of an acid electrolyte suspended in a capillary tube, in which it is caused to move by an applied acceleration. This device represents an attempt to make a continuously-variable indicating instrument out of a step-by-step device.

Contact-making devices are used frequently to detect the moment—or position—of contact between two objects; for example, the contact of a lathe tool with the work, or the contact of the spindle of a mechanical comparator with the piece being measured. These are applications for convenience primarily, although the accuracy of the work may thereby be increased.

In the balanced-diaphragm type of indicator, however, the electrical contact is an essential part of the instrument; a diaphragm normally held by the unknown pressure against an electrical contact may be forced away by compressed air applied to its other side from a controlled source. Separation of the contacts—breaking the electric circuit—signifies that the pressures on the two sides of the diaphragm are equal. This device has had wide application

Continued on Page 244

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(296) N. Davidenkoff. Vibrating-wire Method of Measuring Deformation. *Proceedings American Society for Testing Materials*, Vol. 34, 1934, part 2, pages 847-851.

(296a) R. S. Jerrett. The Acoustic Strain Gage. *Journal of Scientific Instruments* (London), Vol. 22, 1945, pages 29-34.

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ELECTRONIC MECHANISMS for Measurement and Control in Plant and Laboratory

By **THEODORE A. COHEN**, Vice President Engineering and Research, Wheelco Instruments Co., Chicago, Illinois

MODERN Industry owes a great debt to Industrial Physics for the continued progress taking place in the design and improvement of Automatic Control Apparatus. The Process Engineer, concerned with applications of automatic-control systems and the planning of manufacturing processes, is aware of the great industrial benefits derived from incorporating automaticity into his process plan. Because he considers automatic-control mechanisms among his most important tools, he has found that the advent of Electronics has given him new means of obtaining results which until recently were thought almost unattainable.

The electron-tube mechanism has not only complemented a great many earlier purely mechanical devices, but has in many cases supplanted them, while at the same time making available higher standards of operational dependability.

Electron tubes, with their almost infinitely fast and inertialess response, make possible a whole new galaxy of operational devices significant not only in the plant but also in the laboratory.

When one considers that electrons in an evacuated enclosure can travel at a speed comparable with that of light, one begins to become aware of the fascinating possibilities of such mechanisms for control purposes. Space permits only a passing glance at a few recent developments in this field; we must content ourselves with a few of the more significant apparatus designs and leave to the reader's ingenuity the specific applications of such devices.

In a large majority of automatic-control systems, the problems solved are "translating-and-relaying" problems. That is to say, a change in a measured condition such as temperature, pressure, flow or level is translated into a change of pointer position or a change of energy in order to command an operative mechanism which may indicate, record, control, or do other desired useful work.

Because of the great versatility of the electron-tube mechanism, it is applied to many different relaying problems. Of the many useful functions that the electron tube may be called upon to perform, probably none is more fascinating than its generating high-frequency alternating current when used in a suitable circuit. That the electron-tube high-frequency generator is the heart of modern radio communication is widely known; that this system can be made to function as an almost ideal relaying mechanism is not so widely known.

As an index to the possible uses for these generator systems outside the field of communications, the number and variety of their applications may be mentioned. These range from the important instrument type relay (in which the oscillator mechanism is associated with a sensitive measuring instrument such as a microammeter and commands auxiliary electromechanical devices without disturbing the measuring mechanism) to systems for measuring liquid level in a storage tank without the use of intermediate moving mechanical devices. The electron-tube oscillator is the heart of such relaying apparatus and the key to the design of an almost infinite variety of technical equipment.

EARLY CONTACT-MAKING INSTRUMENTS

In the plant as well as in the laboratory, there are required high-sensitivity measuring instruments such as galvanometers, microammeters, torsion balances, and the like. Whether these instruments are of the direct-deflection class or of the null-balance class, they usually incorporate a pointer and a calibrated or center-zero scale for indicating unbalance. Automatic-control apparatus likewise incorporates some form of measuring system because—as Behar put it fifteen years ago—*"before a condition can be controlled it must be measured."*

An obvious means whereby a measured change in the variable condition commands a powered device such as a signal system or a materials control valve is to associate an electrical contacting mechanism with the moving element (pointer, etc.) of the measuring system.

Electrical contacting mechanisms, when applied to sensitive measuring systems, have until recently taken two differing general design forms.

One method has been the incorporation of a motor-driven mechanical detenting mechanism whereby the position of the pointer is sensed by a mechanical clamping system, which in turn determines the closed or open condition of the contacts. This method introduces a delay in the measurement (since the pointer is clamped during the sensing interval) and it usually requires the use of a relatively rugged measuring system, to withstand the action of the mechanical clamping mechanism.

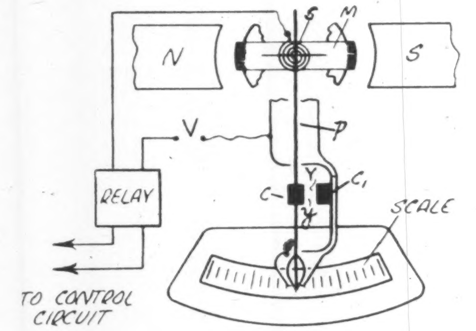

Fig. 1

A second method, Fig. 1, makes use of an electrical contact mounted upon the moving element of the measuring system (usually upon the pointer itself) which engages a mating contact whose position on the scale can be preset. These contacts constitute the **PRIME RELAY**, whose function is to open or to close a circuit to a secondary or "pilot" relay which, in turn, commands the final power device of the automatic-control system.

Obviously, both methods entail drawbacks from the standpoint of design as well as that of function. The first method introduces undesirable delays and requires an enhanced ruggedness of the measuring system. The second method sometimes involves instrument re-design since carrying a contact on a pointer usually disturbs the torque-weight ratio. Furthermore, the small forces present in sensitive measuring instruments give rise to problems of (1) contacting failure due to film formation, (2) contact adherence and, of greatest importance (3) impairment of accuracy by reason of the electrostatic force fields associated with the contact surfaces.

Because a satisfactory electrical contacting mechanism for use with sensitive measuring systems is essential to dependability of automatic-control apparatus, and because this involves force phenomena in electromagnetic and electrostatic fields, a short analysis of the effects in these fields will be pertinent.

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*Substance of a paper presented at the National Electronics Conference, Chicago, Oct. 5-7, 1944; re-written by the author (and some illustrations revised) for publication in *Instruments*.

Referring to Fig. 1, there will be noted a conventional contact-making electrical measuring instrument which in this case is of the d'Arsonval moving-coil variety. (Such contact-making arrangements have been applied to many forms of measuring systems.) There will be noted an instrument indicating pointer P lying above a calibrated scale and carrying an electrical contact C. A mating contact C_1 is mounted upon a setting-arm which can be moved to any desired point on the scale. A source of electric energy V in circuit with a pilot relay and the contact system supplies energy for the secondary relay when an upscale motion of the pointer P closes the contact system C-C_1. The relay controls, by means of its contacts, auxiliary apparatus in the control circuit.

Two major force disturbances are present in this form of mechanism:

1. The source V creates an electrostatic field at Y which upon the approach of contact C to contact C_1 introduces an attractive force between the two contact faces. This force produces an *upscale* displacement of the pointer, the extent depending on δy.
2. With the contact faces in partial contact but separated by surface films, a relatively large attractive force will *delay* parting of the contacts as the energy in the measuring system falls.

Both these effects of electrostatic field produce measurement errors. The extent of these forces will be shown in the following:

COMPUTING THE VALUES OF ERROR-PRODUCING ELECTROSTATIC FORCES

Referring to Fig. 2, let us assume that the contact faces C and C_1 represent the boundary conductors of an electrical capacitance having air as the dielectric between the faces. The energy is actually stored in the dielectric. Therefore, the energy stored per cubic centimeter of dielectric is:

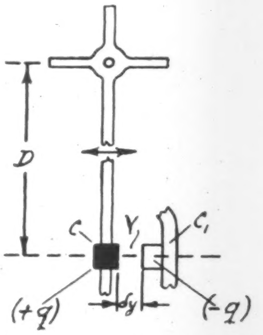

Fig. 2

$$\frac{KF^2}{8\pi}\text{ ergs}$$

where F is the field intensity in statvolts per cm. (cgs. system); and K is the dielectric constant (approx. 1 for air).

Assume C and C_1 represent the contacting system having substantially parallel surfaces of equal area and close together, having a charge of q and $-q$ respectively. If the areas are assumed equal the surface density of charge Q is the same on both surfaces and the intensity between the surfaces at all points is by Coulomb's Theorem:

$$F = \frac{4\pi Q}{K}\text{ dynes}$$

Now let the distance between the surfaces be increased by the small distance δy and letting P dynes represent the force of attraction between the surfaces, the work done will be $P\delta y$ ergs.

(Assumption must be made that the effect of edge-fringing field is negligible and that the separation is small enough so that the field intensity is unaffected thereby.)

If the area of the contact surface in cm.^{2} be represented by A, the increase in energy stored due to the increase in dielectric volume will be:

$$\frac{A\delta y KF^2}{8\pi}\text{ ergs} = \text{work done.}$$

$$\therefore P\delta y = \frac{A\delta y KF^2}{8\pi} \text{ and } P = \frac{AKF^2}{8\pi}\textbf{ dynes}$$

where $d = \delta y$, $F = V/d$, and V is potential difference.

Therefore, in terms of V and d,

$$P = \frac{AK\ (V/d)^2}{8\pi} = \frac{AKV^2}{8\pi d^2}\text{ dynes} \quad . \quad . \quad . \quad (1)$$

If in terms of Q and q,

$$P = \frac{AKF^2}{8\pi} = \frac{AK}{8\pi}\left(\frac{4\pi Q}{K}\right)^2$$

$$\therefore P = \frac{2A\pi Q^2}{K} = \frac{2\pi Qq}{K}\text{ dynes} \quad . \quad . \quad . \quad (2)$$

since $q = AQ$.

(The above values are in esu. of cgs. system.)

Since the potential applied at V for energizing the secondary relay may be of the order of several volts or upward, the electrostatic forces acting upon the pointer of a sensitive instrument may become a considerable fraction of the measuring torque of the instrument. The torque produced by such disturbing forces is $(P \times D)$. Reference to Table I will indicate the usual design ranges in dyne-cm. per degree rotation of representative forms of electrical measuring instruments. A few trial calculations involving the data in expressions (1) or (2) above, and choosing reasonable values for the mechanical geometry of the contact mechanism, will make apparent the extent of the disturbing force and the sometimes considerable fraction such a force represents of the total available useful instrument forces.

TABLE I

Types of deflecting-pointer instruments	Design torque ranges in dyne-centimeters per degree rotation
Pivot-and-jewel-mounted Moving System, Spiral-spring Restoring Force	
D-c. Microammeters	0.140-0.200
D-c. Milliammeters	0.150-0.250
D-c. Galvanometers	0.090-0.180
D-c. Millivoltmeters	0.156-0.294
Electrostatic Voltmeters	0.120-0.285
Rectifier types	0.120-0.190
Thermoconverter types	0.060-0.140
A-c. Moving-iron types	0.290-0.650
A-c. or d-c. Dynamometer	0.410-0.860
Single-suspension	
D-c. Galvanometer	0.015-0.090
Dual-suspension	
D-c. Galvanometer	0.060-0.120

A similar analysis may be made of the second disturbing effect previously mentioned by making use of the previous expression (1).

$$P = \frac{AKV^2}{8\pi d^2}\text{ dynes}$$

where A = Area in cm.^{2} (contacts assumed equal in area and parallel)
V = Potential in esu.
d = Distance between contacts in cm. (Film thickness may be about 0.01 to 0.05 mm.)
K = Dielectric constant of film (may be as high as 80)

In this case it will be noted that the dielectric medium is a film of thickness $d(=\delta y)$. All contact materials, depending upon the particular atmosphere, can form upon their faces a semi-conducting film having possible thicknesses of the order of a fraction of a millimeter. Inasmuch as the forces present are also a function of the dielectric constant of the film, such forces may reach relatively high values.

In order to minimize the total effect of these forces, many designers have resorted to various expedients such as reducing the areas of the contacts, reducing the potential V (and, therefore, requiring an increase in sensitivity of secondary relays), changing the relative areas of the contact faces with respect to each other or changing the shapes of the contacts. These expedients do not eliminate the force disturbances but only reduce their effect, requiring in all cases a compromise between allowable disturbance error and desired accuracy. Such compromises usually have limited the application of contact-making instruments.

The advent of the electronic oscillator mechanism as a relay device has made possible a new approach to such design problems.

OSCILLATOR RELAY—GENERAL DESCRIPTION

The basic circuit from which has been evolved the oscillator type relay is shown in Fig. 3 which is almost self-explanatory, needing only the statement that the circuit functions at a frequency of approximately 15 megacycles. It will be noted that this is a well-known form of electronic oscillator: the tuned-plate tuned-grid circuit due to Kühn-Huth, in which resonant tanks consisting of inductances and capacitances in parallel (L_1C_1 and L_2C_2) are placed respectively in the plate and grid circuits of the electron tube. In this circuit, coupling takes place through the grid-plate interelectrode capacitance of the tube and sustained oscillations are produced when the plate and grid tanks are both resonant at approximately the same frequency. Under these conditions the steady plate current is at some low value based upon the strength of oscillations and, therefore, upon the bias applied to the grid, by reason of the presence of the grid leak and capacitor.

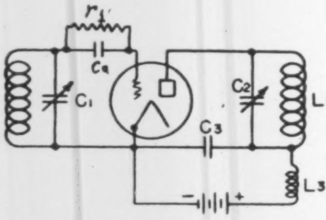

Fig. 3. Basic oscillator circuit, tuned-plate tuned grid.

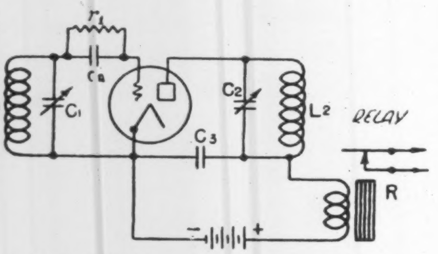

Fig. 4. Basic circuit converted for relay use.

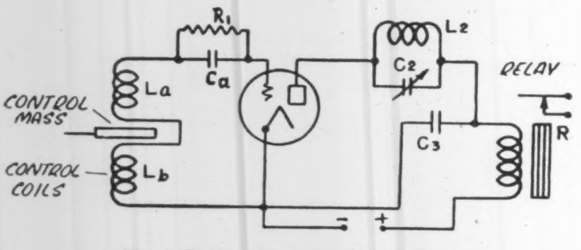

Fig. 5. Instrument application of the circuit.

If one of the resonant tanks present in either the grid or the plate circuit is detuned, the strength of oscillations is decreased considerably or, under properly chosen conditions, halted entirely with the consequent disappearance of grid bias and a consequent rise in steady plate current. By properly choosing circuit components, applied voltages and tube characteristic, it is possible to produce large changes in plate current with small departures from resonance. Since either the grid tank or the plate tank may be deresonated, or reresonated, by a change of inductance or capacitance in the proper direction, a variety of control methods by change of either inductance or capacitance and consequent control of plate current can be obtained. By introducing an electromagnetic contact-making relay into the plate circuit, the plate current change may be made to perform useful function. See Fig. 4.

APPLICATION AS AN INSTRUMENT RELAY

In Fig. 5, the circuit illustrated in Fig. 4 has been modified to permit inductance L_1 to be rapidly affected by a small motion of a metallic control mass attached to the pointer of a sensitive measuring instrument. (Such an instrument assembly may be seen in Fig. 13.)

The modification consists in replacing L_1 of Fig. 3 with the split inductance L_a and L_b. Capacitor C_1 has been eliminated since inductances L_a and L_b are shunted by their own distributed capacitance as has been pointed out by Lorenz in his "TNT" modification of the tuned-plate tuned-grid oscillator.

The control mass in most industrial forms of the apparatus takes the form of a light metal foil flag, usually of aluminum, rigidly attached to the instrument pointer. Because of the small sizes of such flags (0.002″ × 0.375″ × 0.750″), their weights have little disturbing effect upon the torque-weight ratios of sensitive measuring instruments. Inductors L_a and L_b are positioned at either side of the path of the flag in such manner that the flag may pass between these inductors without touching them.

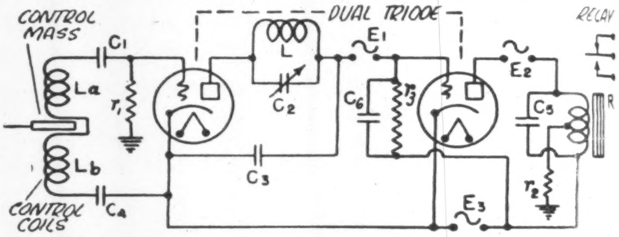

Fig. 6. Oscillator relay; commercial variation: self-rectification.

The introduction of the metal flag between these inductors reduces their inductance and increases their effective (high-frequency) resistance as will be shown later. These changes in inductance and resistance can be designed to cause large departures from, or to, resonance in the oscillator circuit, and thereby result in large changes in the steady-state plate current I_p.

THE CONTROL INDUCTANCE

It is desirable from the standpoint of obtaining large changes in plate current (ΔI_p) with small changes in pointer position ($\Delta I_p/\delta y$) that the inductance change (ΔL_t) with flag motion be as large as possible. One method of attaining such a condition is to concentrate the inductance in as small a volume as possible consistent with the design of an effective inductor and allowable space considerations.

A good form for such inductors has been determined to be the plane face spiral sometimes termed "single layer radial" or "pancake" form. Such inductors can be designed to have narrowly defined electromagnetic fields, small geometry, and high effective inductance. The inductance of such coils (parameters from Figs. 7, 8, and 9) is given in microhenries to an accuracy of about 3% by the following expression:

$$L_{1\text{ or }2}=\frac{\{[(W-ID)+ID]/2\}^2N^2}{8\{[(W-ID)+ID]/2\}+11[(W-ID)/2]} \quad (3)$$

(All dimensions in inches)

The use of two such spiral inductors placed coaxially with planes parallel and connected series aiding give us a total lumped inductance L_T with small cubic dimensions in which

$$L_T=[L_1+L_2+2M]\text{ microhenries} \quad . \quad . \quad . \quad (4)$$

where M is the mutual inductance in microhenries. Calculation of M by formulae is a rather tedious task but measurements of M in a number of cases have shown a range from

$$M = 0.82\,L_1 \quad . \; . \; . \; . \; . \; . \; . \quad (5)$$

where $D = 2t$, to

$$M = 0.64\,L_1 \quad . \; . \; . \; . \; . \; . \; . \quad (6)$$

where $D = 5t$ as in Fig. 8.

INDUCTANCE DECREASE WITH FLAG IN FIELD

Upon entry of the metal flag between the faces of the inductances L_1 and L_2 there will be found to take place a sharp decrease in the total inductance L_T as well as an increase in the effective (radiofrequency) resistances of the inductances. The reason for this decrease in inductance is that whenever a metallic material is brought into the fields of an inductor carrying alternating current there is induced in the metal an alternating potential which in turn causes an alternating current to flow in the material. Such currents, termed eddy or Foucault currents, set up a magnetic field opposing the field of the inductor, reducing the net field surrounding the inductor, with a consequent change in the effective coil inductance and a resultant decrease in the inductance value. The reduction of the effective inductance depends upon the frequency and upon the constants of the flag material. As an approach to an analysis of the inductance change with metal flag entry into the inductive field, we may consider the flag as a short-circuited secondary turn of a transformer in which its inductance may be represented as L_F and its resistance as R_F. This resistance is, of course, the high-frequency resistance of the flag and takes into account skin effect. Since the oscillator relay functions in the frequency range of approximately 15 megacycles, the value R_F will be considerably higher than its steady-current resistance. The value R_F may be obtained with close enough approximation from the following expression

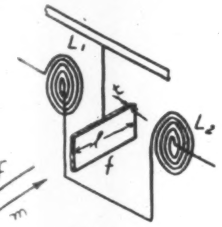

Fig. 7

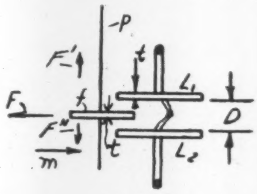

Fig. 8

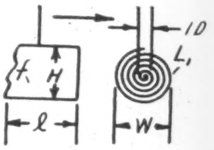

Fig. 9

$$R_F = R_{DC}[1 + 1/12\,A^2 - 1/180\,A^4] \text{ ohms} \quad . \; . \; . \quad (7)$$

where $A = [2\pi f l \mu]/[10^9(lS/tH)]$.
R_{DC} = Steady current resistance
f = Frequency (in this case 15×10^6 cps.)
l = Flag length in cm.
t = Flag thickness in cm.
H = Flag height in cm.
S = Resistivity in ohms/cm.³
μ = Permeability (in this case 1 for aluminum)

The inductance of the flag (in emu. of cgs. system) may be obtained within close enough limits for the purpose from the expression

$$L_F = 4\pi a\{[1 + (r^2/8a^2)]\log_e(8a/r) + (r^2/24a^2) - 1.75\} \quad (8)$$

$$\left.\begin{array}{l}\text{where } a = (W - ID)/2 \\ \text{and } r = t/2\end{array}\right\}\text{parameters from Figs. 7 and 9.}$$

(Notes: All dimensions in centimeters. L_F in emu. of cgs. 1 emu. abs. in cgs. system = 10^{-9} henry, practical unit.)

Therefore—Letting I = current in L at frequency $\omega/2\pi$
The induced voltage in flag $E_F = \omega M_0 I$
The induced current in flag $I_F = E_F/Z_F = \omega M_0 I/Z_F$
The current I_F lags E_F by an angle θ
The reactive component of I_F is $I_F \sin\theta$ and therefore 180° behind I
$\therefore$ Voltage induced in L_T due to $I_F \sin\theta$ is

$$\begin{aligned} E_{LR} &= \omega M_0 I \sin\theta \\ &= (\omega M_0 I/Z_F)^2\,\omega L_F \quad . \; . \; . \; . \; . \quad (9)\end{aligned}$$

where Z_F is flag impedance and M_0 is mutual inductance between coil and flag.

Then total reactive voltage in L_T is

$$\omega L - \left(\frac{\omega M_0 I}{Z_F}\right)^2 \omega L_F = \omega\left[L - \left(\frac{\omega M_0 I}{Z_F}\right)^2 L_F.\right]$$

$$\therefore L' = L - \left(\frac{\omega M_0 I}{Z_F}\right)^2 L_F \quad . \; . \; . \; . \; . \quad (10)$$

$$\therefore \Delta L = -\left(\frac{\omega M_0 I}{Z_F}\right)^2 L_F. \quad . \; . \; . \; . \; . \quad (11)$$

It is therefore seen that the effect of the induced current in the flag is to decrease the self inductance of the coils by the amount $-\left(\frac{\omega M_0 I}{Z_F}\right)^2 L_F$.

NOTE: Under the conditions of expression (6) the introduction of the metal flag having an area equal to $1.3W^2$ into the coil system reduces M to $0.08\,L_1$ at a frequency of 15 megacycles, by reason of shielding effect of flag. The value L is the unshielded inductance obtained from expression (3) and since from (4)

$$L_T = L_1 + L_2 + 2M \text{ (with flag withdrawn);}$$

$$\text{new } L_T = L_1 - \Delta L + L_2 - \Delta L + 2(0.08L) \quad . \; . \quad (12)$$

Because the energy involving the circulation of the induced eddy currents is drawn from the field of the inductor there is an apparent increase in the effective resistance of the inductor.

An analysis may be made as regards resistance increase of the coil system L_1 & L_2 due to the entry of metallic flag into the electromagnetic field. For example, from above:

Induced current I_F in flag $= \omega M_0 I/Z_F$

The current I_F lags behind E_F by an angle θ and, therefore, may be defined as $\tan\theta = \omega L_F/R_F$.

The active component of I_F is in phase with E_F and so

$$I_F \cos\theta = \frac{\omega M_0 I}{Z_F} \times \frac{R_F}{Z_F}$$

Voltage induced in L by $I_F\cos\theta$ is $I_F\cos\theta\,(\omega M_0 I)$ and

$$E_{LA} = \frac{\omega M_0 I}{Z_F} \times \frac{R_F}{Z_F}\,\omega M_0 = \left(\frac{\omega M_0 I}{Z_F}\right)^2 R_F$$

Since E_{LA} lags 180° behind I it can be considered an IR reaction and, therefore $(\omega M_0 I/Z_F)^2 R_F$ represents an increase in effective resistance of L_1 or L_2, and the apparent resistance becomes

$$R' = R_L + \left(\frac{\omega M_0 I}{Z_F}\right)^2 R_F \quad . \; . \; . \; . \; . \; . \quad (13)$$

$$\text{and } \Delta R_L = +\left(\frac{\omega M_0 I}{Z_F}\right)^2 R_F \quad . \; . \; . \; . \; . \; . \; . \quad (14)$$

The effect of the induced currents in the flag, therefore, is to increase the effective resistance of the coils by the amount $(\omega M_0 I/Z_F)^2 R_F$.

Both the decrease in inductance $-\Delta L$ and increase in effective resistance ΔR_L introduces control effects upon the oscillator in a direction required for obtaining large changes in plate current since the inductance decrease deresonates the system, while the resistance increase, reduces resonant energy.

POSSIBLE DISTURBING FORCES

The flow of high-frequency alternating currents through the inductances L_1L_2 gives rise to both an electromagnetic and an electrostatic field in their vicinity. Since both these fields are a function of the current and potential in these inductances it is conceivable that some disturbing forces might act upon the control flag F and the instrument pointer to which it is attached. The energy levels are exceedingly low and the disturbing effects are negligible. Nevertheless, it may be of some interest to analyze these effects.

In general, two force phenomena are of interest. The introduction of a conductive non-ferrous metal flag into the magnetic field of inductance L_T gives rise to a repulsion phenomenon because of eddy current induction in the metal flag, while induced electrostatic charges upon the flag due to the electrostatic field may introduce some attractive force.

ELECTROMAGNETIC REPULSION EFFECT

If a non-ferrous metal disk is so placed in an alternating magnetic field that the lines of force pass through the disk, an alternating potential will be set up in the disk. This potential will be 90 degrees in phase displacement from the magnetic flux and will cause a current flow in the material. This current sets up a reactive field which exerts a force tending to move the material in the magnetic field, this force being proportional in magnitude and direction to the product of the corresponding instantaneous values of current and flux. The force for any period is equal to the average of the instantaneous forces during the period. If the disk had no self inductance the current phase would be in quadrature with the inducing flux and the average forces during alternate quarter-periods would be equal but in opposite directions, so that the average force during the whole period would be zero and, consequently, the disk would not tend to move in the field.

However, in actuality, even a flat metal sheet has some inductance and, therefore, the induced current would lag behind the induced pressure. The current phase, therefore, would be more than 90° behind the magnetic phase. Under these conditions a summation of the instantaneous forces during a half-period would reveal a larger average force, having a finite negative value, than the summation of the instantaneous forces in the corresponding alternate period. The result is a small repulsive component between the two fields. This may be more readily apparent from the following simplified analysis.

Assuming that the flag is threaded by a magnetic flux $MI_0\sin\omega t$ due to a current $I_0\sin\omega t$ in coils L_1L_2. The induced emf. in the flag due to $I_0\sin\omega t$ is

$$E_F = M\omega I_0 \sin(\omega t - \pi/2) \quad . \quad . \quad . \quad . \quad (15)$$

Now E_F lags behind I_0 by 90° and if we neglect inductance L_F of flag the induced current I_F will be in phase with E_F

$$\therefore I_F \propto M\omega I_0 \sin(\omega t - \pi/2) \quad . \quad . \quad . \quad . \quad (16)$$

It will also be seen that the force between the two currents is proportional to their product I_0I_F.

$$\therefore \text{Force} \propto M\omega I_0{}^2 \sin\omega t \sin(\omega t - \pi/2) \quad . \quad . \quad (17)$$

One will immediately recognize that the mean of the quantity $\sin\omega t(\sin\omega t - \pi/2)$ in which the harmonic components differ in phase by 90° is zero.

$$\therefore \text{If } L_F = 0, \text{ mean force} = 0.$$

However, L_F although very small, can never reach zero and, therefore, the current I_F lags in phase behind I_0 by more than 90°.

THE FINAL FORCE DERIVATION

Under these conditions

$$\therefore \text{Force} \propto M\omega I_0{}^2 \sin\omega t \sin(\omega t - \pi/2 - \theta) \quad . \quad . \quad . \quad (18)$$

and

$$\propto M\omega I_0{}^2 \sin^2\omega t \cos\left(\frac{\pi}{2} + \theta\right) - \frac{M\omega I_0{}^2}{2} \sin 2\omega t \sin\left(\frac{\pi}{2} + \theta\right)$$

Mean value of last term $= 0$

Mean value of first term $= \frac{1}{2} M\omega I_F \cos(\pi/2 + \theta)$

Because $\cos \pi/2 + \theta$ is negative when θ is small, the force upon flag is theoretically one of repulsion, the flag experiencing a repulsive impulse once every cycle.

The repulsive force increases with ω and $I_0{}^2$ and reduction in R_F. However, as ω increases, R_F also increases due to skin effect, and changes in ω and R_F create little change in repulsion force.

Because the energy present in the inductances L_1L_2 is minute, the repulsive forces are negligible. The small force possibly remaining is effective normal to the plane of the flag, and parallel to the axis of the inductances L_1L_2 and instrument pointer. These remaining minute force effects are, therefore, cancelled out and do not affect instrument indications.

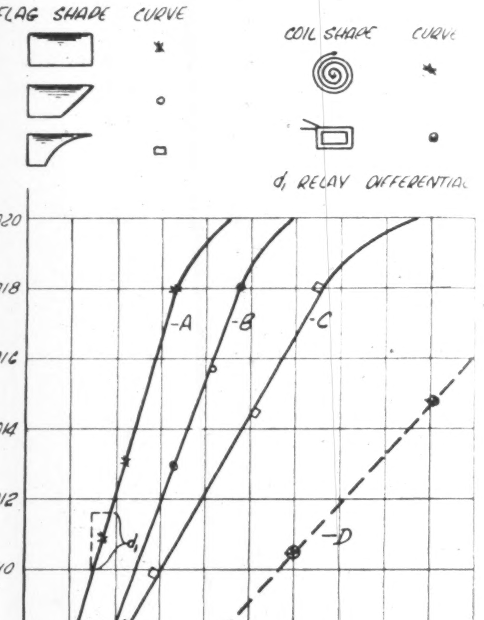

Fig. 10

Because the existence of an electromagnetic field entails the presence of an electrostatic field, the introduction of a metal flag into the field of inductors L_1 and L_2 may cause electrostatic charges to form on the flag surfaces. Such charges, if different in sign from charges present upon the plane faces of the inductors, may give rise to feeble attractive forces. The slight effect of such induced electrostatic charges is completely eliminated, however, by insuring that the metal flag surface is at the same potential level as the inductor surface by an appropriate leakage resistor network and proper earthing.

In delicately-balanced instruments, a number of measurements were made of the forces due to the high-frequency electromagnetic fields and of the force due to electrostatic charges. The results of these tests indicate that well designed coil-and-flag arrangements may be used on instruments whose torques are as low as 0.013 dyne-cm. per degree rotation.

INDUSTRIAL FORM

The battery-operated circuit illustrated in Fig. 5 and discussed above for purposes of analysis has been used in experimental apparatus but is obviously unsuited to industrial applications. A much more practical form is illustrated in Fig. 6. This circuit has been rearranged for complete a-c. line energization. The split inductances previously described are again used as the grid-control coils L_a and L_b. Inductance L and variable capacitance C_2 form the corresponding resonant tank for the oscillator. Energy for the plate circuit of the oscillator is supplied at terminals E_1 from a secondary winding of a transformer not shown.

When the oscillator has been resonated, oscillations will occur by reason of the coupling inherent in the interelectrode capacitance between grid and plate, during every positive swing of the raw a-c. supply to the plate circuit. The r-f. by-pass capacitor C_3 by-passes r-f. energy around load and source E_1. The steady low plate current component at resonance due to the grid bias produced by grid resistor r_1 flows through the oscillator plate coupling resistor r_3. The potential across r_3 biases the grid of a succeeding direct-coupled amplifier stage in whose plate circuit appears another source of alternating voltage E_2 and the relay R.

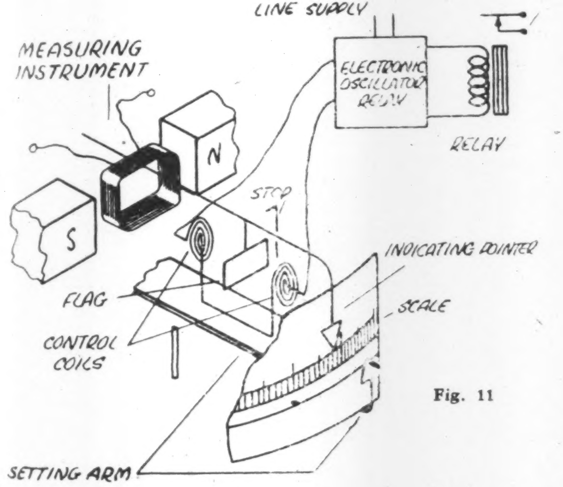

Fig. 11

Since the steady plate current component in the oscillator plate circuit can never reach zero no matter what the intensity of oscillation, a compensating bias is supplied at E_3 to offset the normal drop across load resistor due to oscillator minimum plate current at resonance. The effective bias attained on the grid of the amplifier stage is, therefore, the algebraic sums of E_3 and E_{r2} which during the time that the plate potentials are in the positive portions of the applied a-c. cycle, positions the effective bias upon the second grid at approximately zero with a consequent high average plate current in the amplifier stage. This plate current flow maintains relay R in one contact position as previously set. Capacitor C_5 across the relay furnishes energy to the relay during the negative portion of the a-c. cycle and thus prevents chatter.

From the standpoint of design simplicity, the introduction of the direct coupled amplifier stage results in greatly increased overall sensitivity with the obvious advantage of attaining reasonably large plate current levels for the actuation of a high-wattage relay mechanism. For convenience, the oscillator triode and amplifier triode are mounted in a common envelope. Such tubes are obtainable under the name of dual triodes.

Further inspection of the Fig. 6 circuit will illustrate the use of regeneration for establishing bias change upon the grid of the oscillator stage. It will be noted that the bias return for the oscillator grid circuit is taken through bias resistor r_2 via ground from a tap on relay R. The introduction of such regeneration causes large changes in bias upon the oscillator due to plate current changes through the relay and since the direction of bias change is that required to augment the trend of the amplifier plate current change, small changes in flag position initiate large changes in plate current. A study of Fig. 10 shows in curve "A" the effect of flag travel upon plate current in which regenerative bias is used, while curve "D" indicates the change in plate current with flag travel where the regenerative bias is removed and fixed bias is obtained by connecting bias resistor r_1 to cathode. An interesting feature of the apparatus is that within limits the shape of these curves may be modified by properly shaping the flag areas and by changing the geometry of the control inductors L_a and L_b. The effect on the plate current distribution with flag travel will readily be noted from inspection of Fig. 10. By making use of a steep characteristic such as curve "A" with a relay having a small current operating differential and positioning such relay characteristic upon curve "A" (as at d_1) there will be noted the extremely small flag motion required to change relay contact condition. In fact, oscillator relay mechanisms of this type have been made in which micrometric changes of flag position (of the order of 0.0001") cause a change in plate current from cut-off to designed maximum.

RELAY OPERATION

The relay characteristic (operating current differential) should be chosen to permit operation to take place at approximately midpoint upon the I_p-flag-travel characteristic. This insures long service-life or accuracy-life of the mechanism. Tube aging and reduced emission result in a reduction in maximum plate current and in a small upward creepage of minimum plate current. The effects are most noticeable in the "OUT" and "IN" flag positions. Furthermore, choosing mid-point operation allows functioning of relay on a relatively linear portion of the characteristic. (This type of operation is of greater significance where the oscillator mechanism is to be used for a positioning function as in some telemetering and servo systems.)

Study of the apparatus will indicate that the change in plate current ΔI_p may be positive or negative with flag motion depending upon the positioning of the plate capacitor C_2 (Fig. 6).

By *resonating* the oscillator without flag in inductances L_a L_b, a high plate current is obtained in amplifier plate circuit. (See Figs. 6 and 7). Upon entry of flag into L_a L_b the oscillator is *deresonated* and plate current through relay R drops.

In some cases a reversal of this operation is desirable. This may be accomplished by adjusting capacitor C_2 so that the oscillator is *deresonated* and plate current in the amplifier stage is positioned upon the lower edge of the resonant curve skirt (proper side) with flag removed from coils. Upon flag entry into coils, oscillator is *resonated* by inductance change and plate current through relay R rises.

In the former case, relay current *falls* with flag motion into coils; while in the latter case relay current *rises* with flag motion into coils.

The former method is the one commonly preferred where the apparatus is supplied for automatic-control function, since a failure of line supply leaves the contact system of relay R in open condition and thus leaves the *controlled* apparatus de-energized. The stability of circuits of this type is exceptionally good since they are to a great extent self-damping from the standpoint of spurious oscillations while they are to a certain extent self-compensating for line voltage changes. As an example, consider an increase in line voltage to the transformer supplying voltages E_1, E_2 and E_3. Normally, one would expect an increase in line voltage to increase the plate currents in the tube plate circuits. However, an increase in plate current in the first stage increases the negative bias on the amplifier stage with a resultant counteracting effect upon the tendency to an increase in plate current in this stage. The self-compensation in these circuits are usually of the order of 10% in plate current change for the usual line voltage extremes met with in industry. With some sacrifice in sensitivity the compensation effect may be improved to approximately 6%. Where extremely good regulation is required (of the order of 2%) a simple regulating system may be added to the circuit. (The

Continued on Page 248

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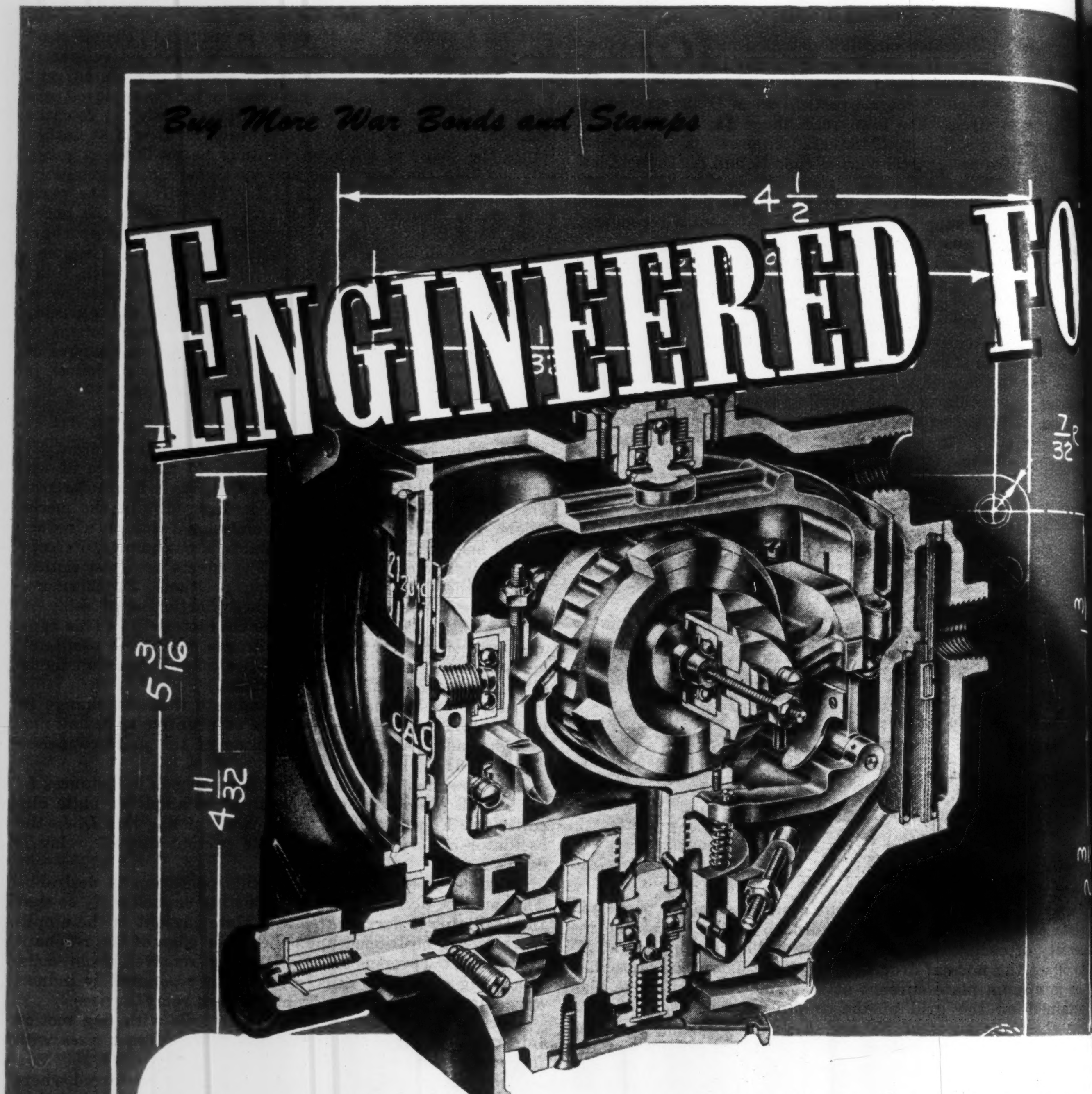

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Future Developments in Instrumentation for All-Weather Air-traffic Control*

By **GLEN A. GILBERT**, Civil Aeronautics Administration

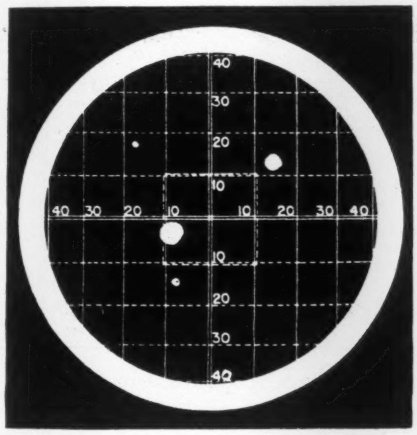

Fig. 1. Screen or dial of collision-warning device which would show a pilot the positions of other aircraft when flying on instruments.

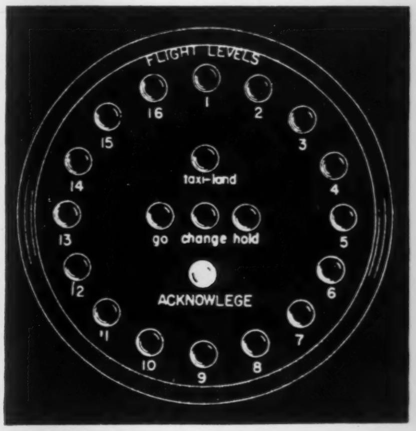

Fig. 2. Traffic-control indicator would automatically provide pilots with a constant, visual portrayal of traffic-control instructions.

SO far, only those developments have been discussed which are definitely known as to characteristics and are expected to be accomplished within the immediate future. nce these developments will not provide a final solution to oblems of air-traffic control anticipated beyond the immeate future, further steps must be taken if the flow of large numbers of aircraft under all weather conditions is to be provided for with minimum restrictions due to traffic confliction.

The war has brought many electronic developments, some of which are still secret. A number of these developments conceivably can be used for air-traffic control purposes. However, it is believed that the best approach to future technical developments for air-traffic control is not just to rely on adapting devices available after the war but to analyze the requirements of air-traffic control and guide developments to meet these requirements.

COLLISION-WARNING INDICATOR

A development considered essential in this respect is an instrument for installation in aircraft which will provide the pilot with the means for avoiding collision with other aircraft on his own responsibility and without dependence on ground directions. Such an instrument, which may be identified as a "collision-warning" device, can be visualized in its general form at this time. Ideally, this device would show a pilot the same view outside of his aircraft in heaviest fog or restricted visibility as he sees on the most beautiful day. While such a device might be within the realm of technical achievement, its weight and cost probably would render it unacceptable from an economic standpoint. Since economic justification is extremely important to civil aviation, the collision-warning instrument that will gain universal application probably will be able to portray only minimum information necessary for a pilot to avoid collision with other aircraft.

As visualized, the collision-warning device of the future should be the size and weight of a present-day compact aircraft radio receiver, and the indicator referred to by the pilot should be about the size of an artificial horizon or perhaps slightly larger. The cost should be comparable to the cost of other equipment necessary today for instrument flight, since such a device ultimately would be a requirement for all aircraft engaged in instrument flight operations in the same manner as two-way radio equipment and a sensitive-type altimeter are requirements today.

Basically, a collision-warning indicator should advise a pilot at all times of the relative separation between his aircraft and other aircraft within a predetermined radius.

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*Extract from "Developments in Air-traffic Control" presented at National Air Transport Meeting of Institute of Aeronautical Sciences, Washington, D. C., October 20, 1944.

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POSITION REPORTER

Another device for installation on board aircraft, whi would be highly desirable from an air-traffic control poi of view, would provide for the automatic reporting of aircraft position and altitude over selected locations. Such locations would be established at the proper intervals along designated airways or other routes of heavy traffic to recor the passing of aircraft automatically, similar to the way that automobile traffic is counted on the highways.

Signals from such a device in an aircraft would be received on the ground at the selected locations, resulting in transmission of the aircraft identification and altitude to each location. The equipment on the ground would add the time and the name of the location and would transmit the data by land lines to the appropriate air-traffic control center, where the information would be recorded automatically before controlling personnel.

A development of this nature would positively and accurately record the movement of aircraft automatically, thus relieving the pilot of the burden of making the numerous two-way radio contacts required today and eliminating the possibilities of error inherent in the present system.

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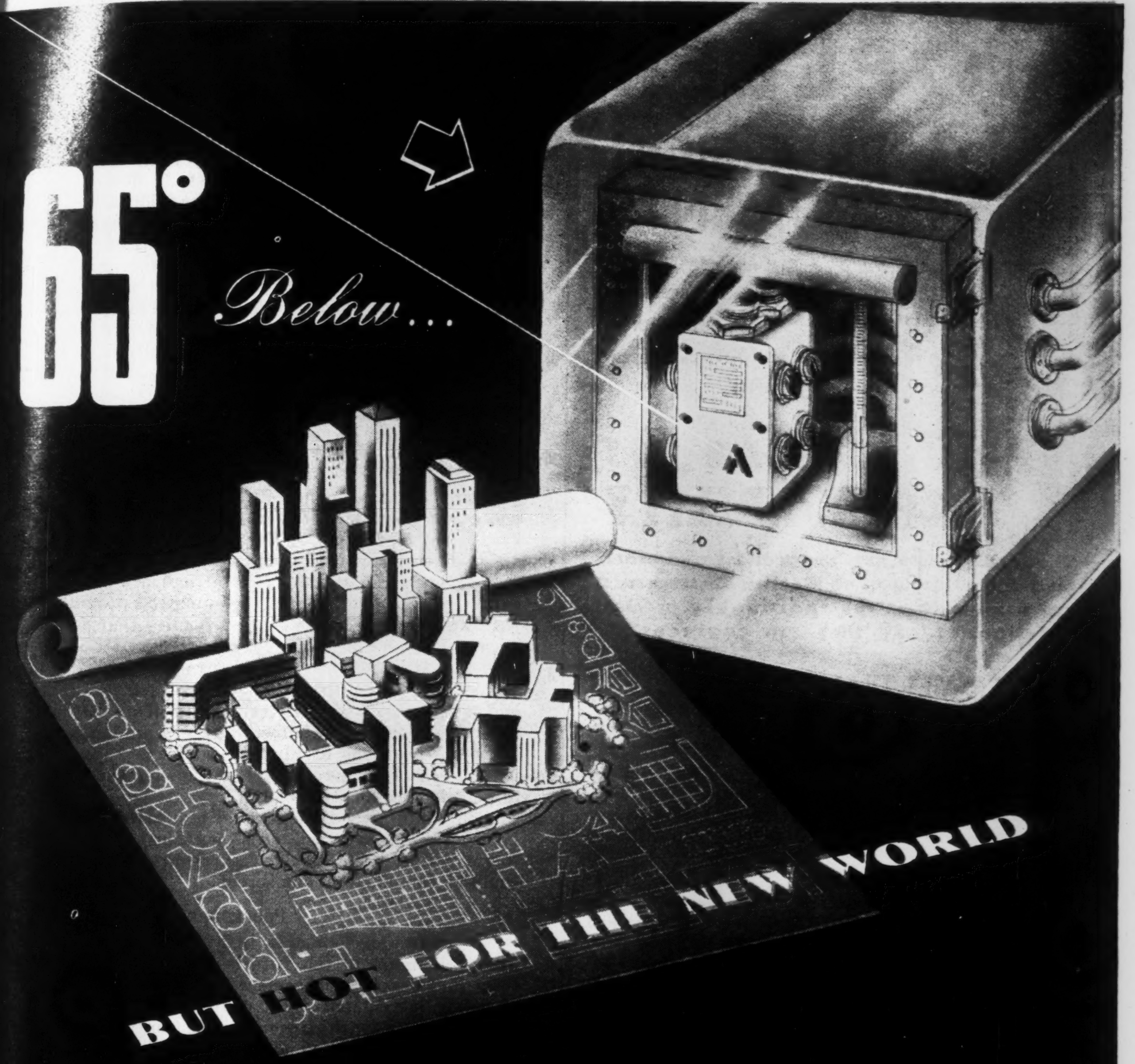
TRAFFIC-CONTROL INDICATOR

One further device is visualized for installation in aircraft which would materially improve the control of air traffic. This would be a traffic-control indicater that would portray to the pilot at all times what he is supposed to do insofar as the control of air traffic is concerned. Such a device would probably use lights arranged in a manner to show certain basic traffic-control instructions similar to the system of red-green-amber lights used in automobile traffic control. The complexity of such an indicator and the amount of in-

65° *Below...*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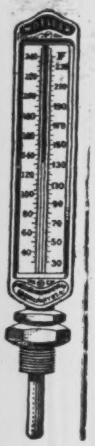

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formation indicated would depend primarily on the form taken by the collision-warning indicator.

Assume that the collision-warning indicator would show only the minimum data previously discussed—vertical separation from other aircraft within perhaps 15 miles in the front hemisphere. The traffic-control indicator would then have to show instructions indicating "PROCEED," "HOLD," "CLIMB," and "DESCEND," "LAND," "TAXI," and "TAKE OFF." If such a device could be successfully developed, it would further simplify the problems of the pilot, and the language difficulties involved in international air navigation would be practically eliminated insofar as air-traffic control is concerned. This device would be optional and probably could be afforded only by the operators of large aircraft.

To summarize future traffic-control requirements for aircraft equipment: A collision-warning device *must* be developed which will be acceptable technically and economically for installation in all aircraft operating in restricted visibility conditions; an automatic position reported and a traffic-control indicator are developments that are desirable but which would not necessarily be required in all aircraft.

GROUND FACILITIES: SCANNING SCREEN

Ground facilities of the future required to permit the safe and expeditious flow of a large volume of traffic will be influenced by the extent of the development of aircraft equipment for traffic-control purposes. If automatic aircraft position reporting and traffic-control indicators are in use, the corresponding ground facilities must be provided.

However, there is one ground facility that appears highly essential to an efficient air-traffic control system of the future that does not necessarily involve related equipment in aircraft. This facility might be termed a "scanning screen" and would be developed for installation in airport traffic-control towers. To be effective, the scanning screen should show the positions of aircraft within a radius of perhaps 25 miles of the control tower and means should be provided to permit identification of the aircraft by control-tower personnel. While two screens could be used to show separately horizontal and vertical cross sections of the airspace, it would be highly desirable if three-dimensional presentation could be combined on one screen.

PROCEDURES

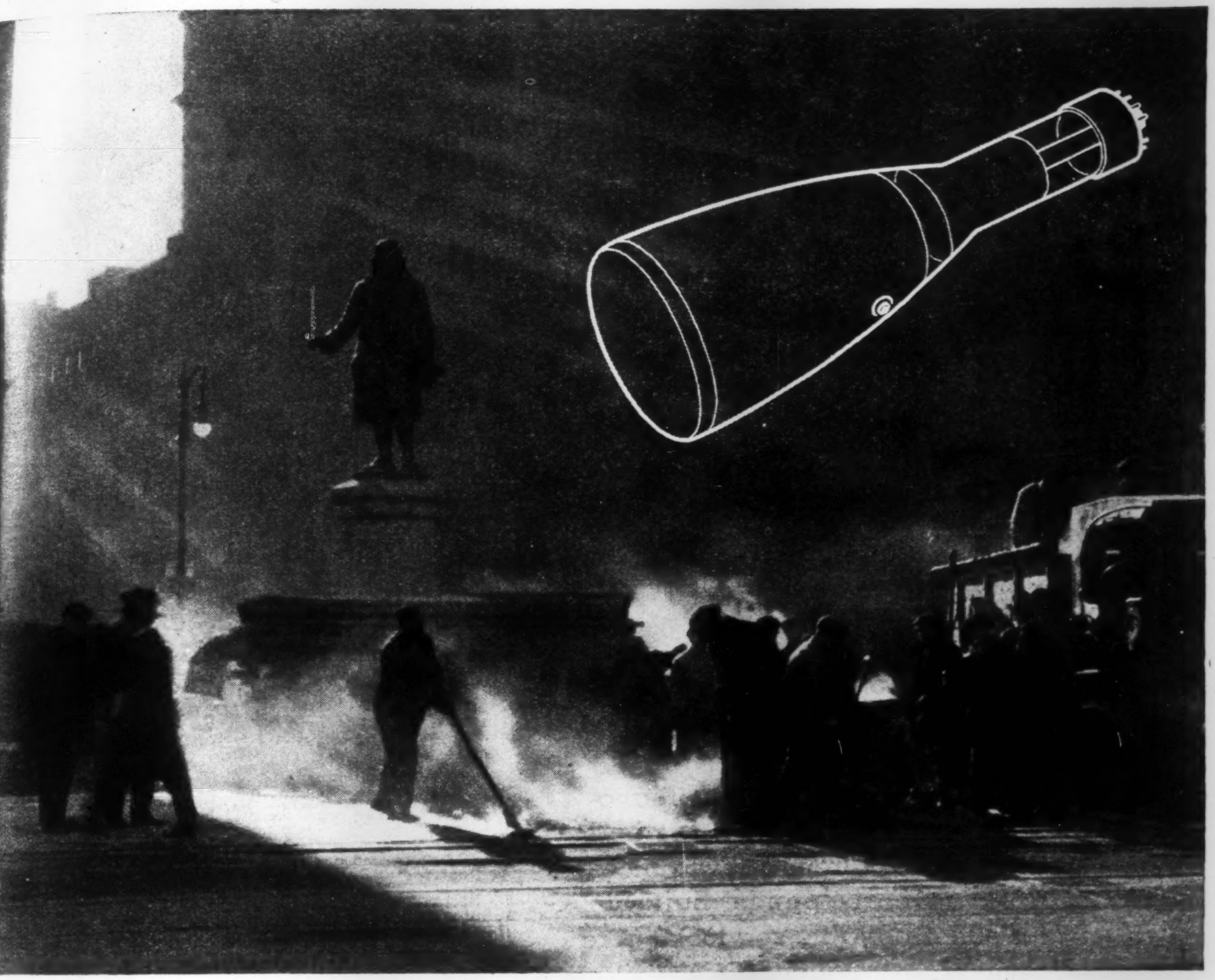
No major developments in air-traffic control procedures are anticipated in the future until new devices along the lines just described become a reality. With all aircraft engaged in instrument flight equipped with collision-warning indicators and with airport traffic control towers provided with scanning screens, definite improvement and simplification in air-traffic control procedures will be possible.

With such devices in use, the emphasis of air-traffic control will be shifted from the prevention of collisions between individual aircraft to the regulation of the flow of air traffic in the interest of insuring the movement of aircraft with minimum delay due to traffic congestion. As a result of these developments, it should be possible to attain the same rate of traffic flow at all times, regardless of weather.

In other words, it is visualized that the air-traffic control system would, in a sense, be comparable to the present-day automobile traffic control system, where automobiles move in groups, each driver avoiding collision with other automobiles on his own responsibility and the groups being regulated so as to permit maximum flow of traffic along the various arteries. It is only through such delegation to the individual pilot of responsibility for the avoidance of collisions that a solution to future air-traffic control problems can be visualized.

Aircraft Communication System Tester Developed by Young Quartette

BALTIMORE.—To four young tool engineers in the electrical group at The Glenn L. Martin Co. goes credit for devising a new tester for communications systems in Martin electric turrets. Already installed at several loca-



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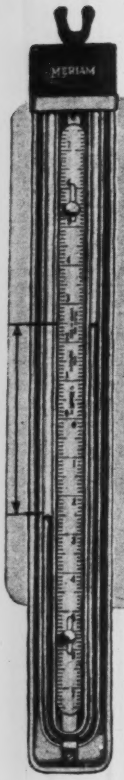

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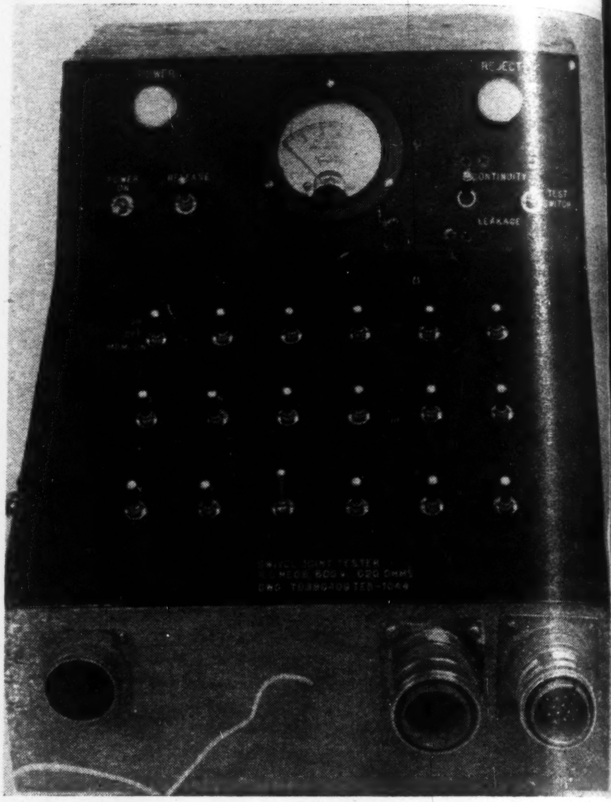

Circuit tester designed by tool engineers.

tions in the company's plants, the new device—an unbalanced electronic bridge circuit—has resulted in a saving of 60 percent of the time originally used for this testing work. The members of the engineering quartette are George Andrews, Leo Douville, Harold Horner and Herman Roemer.

Most difficult of the problems they faced was to evolve a device which would remain consistent while testing circuits. This was necessary in order to permit acceptance only of parts which met manufacturing specifications. Also the wiring problem, owing to leakage in the tester, was a complicated one.

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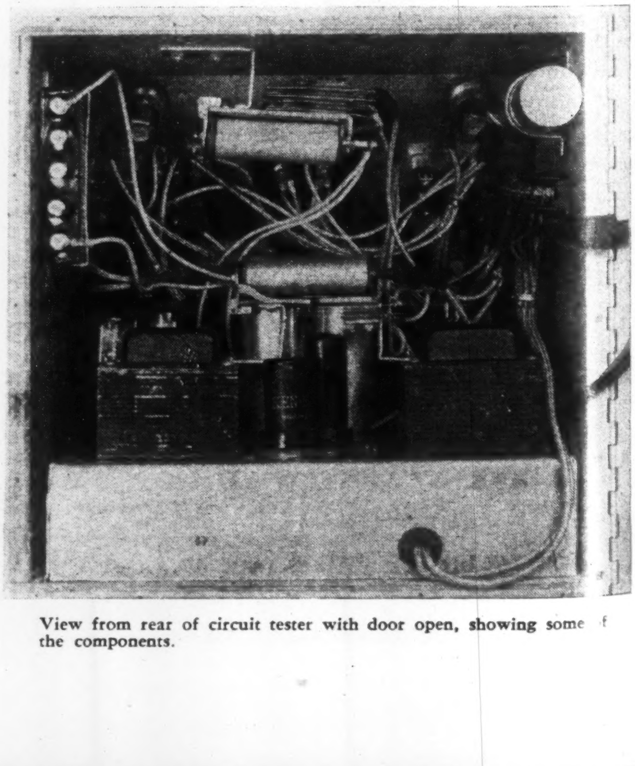

View from rear of circuit tester with door open, showing some f the components.

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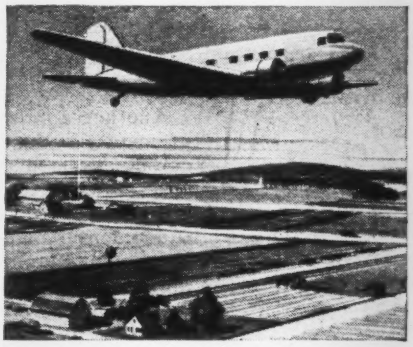

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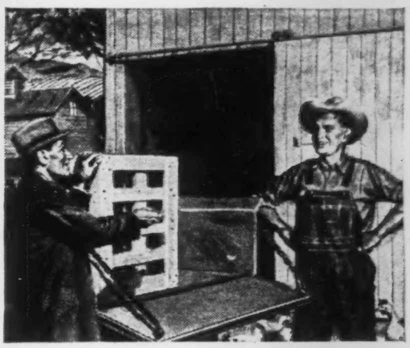

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as the insulation test of 100 megohms at 600 volts. As to the leakage, an unbalance is set up when circuits are insulated at less than 100 megohms and causes a relay to operate, automatically lighting an indicator signal. This light has to be released before tests can continue on other circuits.

Continuity of circuits is checked by passing approximately three amperes through each circuit and measuring the voltage drop. An open circuit is indicated by unbalancing the bridge and causing the red light to glow. An acceptable circuit is indicated on a calibrated instrument.

ELECTRIC GAGING METHODS

Continued from Page 227

in internal-combustion motor study, where it is used in conjunction with the ondographic recorder, and in studies of soil pressure.[304,305]

Some mention must be made of the methods of magnetic analysis used in identification and classification of metals, as contrasted to those previously mentioned, which were intended to detect defects or injuries. These methods—now well established and in wide use—employ usually magnetic circuits which measure either the magnetic permeability of the material, its hysteresis loss, or both. A simple circuit illustrating the general method is given as Fig. 132. The indicating instrument employed here must be adjustable as to phase: it indicates permeability by its deflection, and hysteresis by the phase shift produced. One position of the double-throw switch is used to adjust the instrument; the other to use in making measurements. The method is used for identifying different kinds of material, and for detecting local differences as well.[306,307]

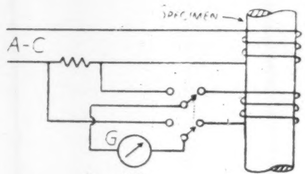

FIG 132

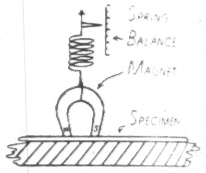

FIG. 133

Another application of magnetic methods is in the measurement of thickness of coatings—magnetic coatings on non-magnetic material, non-magnetic coatings on magnetic base material, or coatings having different magnetic properties on known magnetic base materials.[308,309,310] The fundamental principle is that of the attraction of a small permanent magnet for the specimen; a non-magnetic coating on a magnetic base material reduces the attractive force by an amount dependent on the thickness of the coating. It is ordinarily necessary to calibrate the device experimentally for each type of specimen. In the drawing, Fig. 133, the mode of operation is indicated; this sketch shows a spring-type scale used to provide the force to pull the magnet away from the specimen, but beam-type or torsion balances can also be used.

Another (and academically very interesting) method for the determination of the thickness of thin films is that of electrolytic dissolution. Based upon the principle of the copper voltameter, the method measures the thickness of the film in terms of the quantity of electricity required

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(304) K. J. DeJuhasz. The Engine Indicator: Its Design and Theory. *Instruments*, Vol. 6, 1933, pages 47-52.

(305) A. T. Goldbeck. The Distribution of Pressure Through Earth Fills. *Proceedings American Society for Testing Materials*, Vol. 17, 1917, pages 640-654.

(306) C. W. Burrows. Some Applications of Magnetic Analysis to the Study of Steel Products. *Proceedings American Society for Testing Materials*, Vol. 17, 1917, pages 88-104.

(307) T. Spooner. Magnetic Analysis of High-Speed Steels. *Proceedings American Society for Testing Materials*, Vol. 26, 1926, pages 116-147.

(308) Abner Brenner. Magnetic Method of Measuring the Thickness of Nickel Coatings on Non-Magnetic Materials. *Bureau of Standards Journal of Research*, Vol. 18, 1937, pages 565-583.

(309) Abner Brenner. Magnetic Method for Measuring Thickness of Non-Magnetic Coatings on Iron and Steel. *Bureau of Standards Journal of Research*, Vol. 20, 1938, 357-368.

(310) W. E. Hoare and B. Chalmers. Estimation of the Thickness of Tin Coatings on Steel by a Magnetic Method. *Journal of Scientific Instruments* (London), Vol. 14, 1937, pages 248-249.

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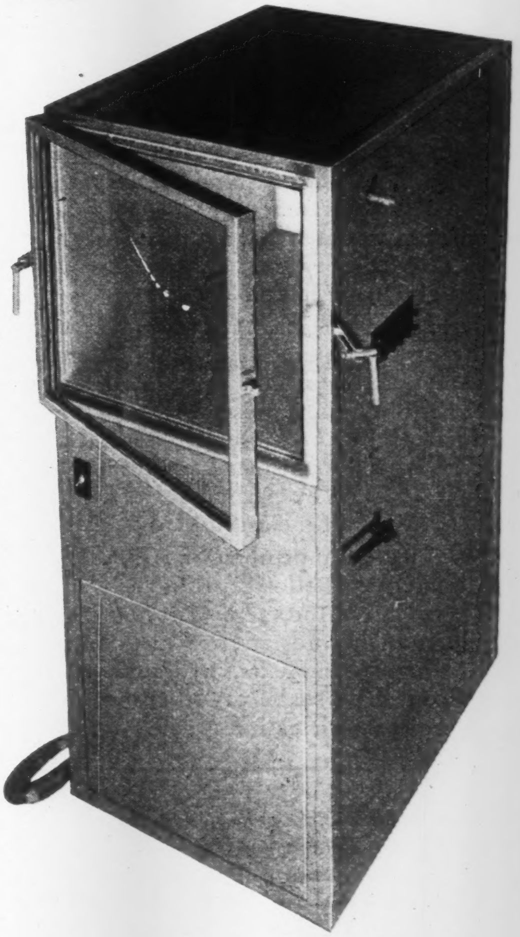

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to remove it by electrolysis. The method has been used to measure the thickness of plated coatings[311] and of extremely thin films of metallic oxides.[312]

The measurement and analysis of thin surface films has also been successfully accomplished with the electron diffraction camera,[313] but this device, with its companion, the x-ray diffraction camera, is a far more promising and useful device for the study of surface treatment and conditions, and in the absolute measurement of internal stresses.[314] The techniques used are highly specialized and somewhat difficult of application—they justify the preparation of a book devoted specifically to them. The x-ray diffraction method is virtually the only means now available for the absolute measurement of internal stresses; it penetrates into the crystal structure of the metal in a manner not achieved by any other method. Much work of this kind has been recently instituted, and much progress is being reported.[315] There is also reason to hope that some of the thermoelastic and magnetic methods may respond to crystalline and intercrystalline phenomena and thus be useful in the direct measurement of stress.[316]

Recently another group of methods, purely electronic in nature, have been applied to the measurement of mechanical magnitudes, and while still new and not thoroughly developed show signs of great promise. These methods employ electron tubes designed for control by external phenomena. The simplest of these are the movable-electrode tubes, in which the positive electrode is attached to a stiff member which enters the envelope through a flexible diaphragm. Movement of this member produces a change in the position of the electrode within the tube, and therefore the effective resistance between electrodes. Either the distance between the electrodes, or their effective area, can be changed.

If the current through a high-vacuum tube is allowed to flow until it is limited only by the space charge, its value will depend upon the dimensions of the tube and the potential applied, in this manner:

$$I = 2.335 \times 10^{-6}\ V^{3/2}\ A/X^2$$

where I represents the electron current, A the effective area of the electrodes, V the applied potential, and X the separation of the electrodes. The current therefore varies inversely as the square of the separation, and directly as the area of the electrodes.

If an electrode assembly like that of Fig. 134A is used, with the two anodes connected together mechanically and so arranged that movement decreases the distance between one anode and the common cathode, while at the same time decreasing the distance between the cathode and the other anode, a push-pull element is produced, which can be placed in a Wheatstone bridge circuit as two adjacent arms, and which will therefore be relatively insensitive to changes in operating characteristics.[317]

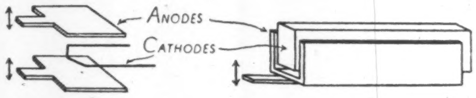

FIG 134

If an electrode assembly like that indicated in Fig. 134B is used, movement of the anode in the direction indicated

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(311) G. G. Grower. Electrolytic Determination of Tin on Tinned Copper Wire. *Proceedings American Society for Testing Materials*, Vol. 17, 1917, pages 130-152.

(312) J. Miley and U. R. Evans. Electrical Measurement of Oxide Films. *Iron and Steel Institute Special Report*, No. 21, 1938, pages 243-248.

(313) Anon. Ford Electronic Camera for Surface Analysis. *Automotive and Aviation Industries*, Vol. 91, Sept. 1, 1944, page 35.

(314) G. Induni. Die Verwendung von Kaltkathodenstrahloszillographen. *Schweizer Archiv*, Vol. 8, Feb. 1942, pages 35-45.

(315) H. R. Isenberger. Bibliography of Stress Analysis by Means of X-ray Back-reflection Method. *Welding Journal*, Vol. 23, Nov. 1944, pages 571s-572s.

(316) T. W. Wlodek. Possibility of Exploiting Magnetic Phenomena in Testing of Steel. *Canadian Institute of Mining and Metallurgy*, Vol. 47, Jan. 1944, pages 5-15.

(317) Ross Gunn. A Convenient Electrical Micrometer and its Use in Mechanical Measurement. *Journal of Applied Mechanics*, Vol. 7, 1940, pages A49-A52.

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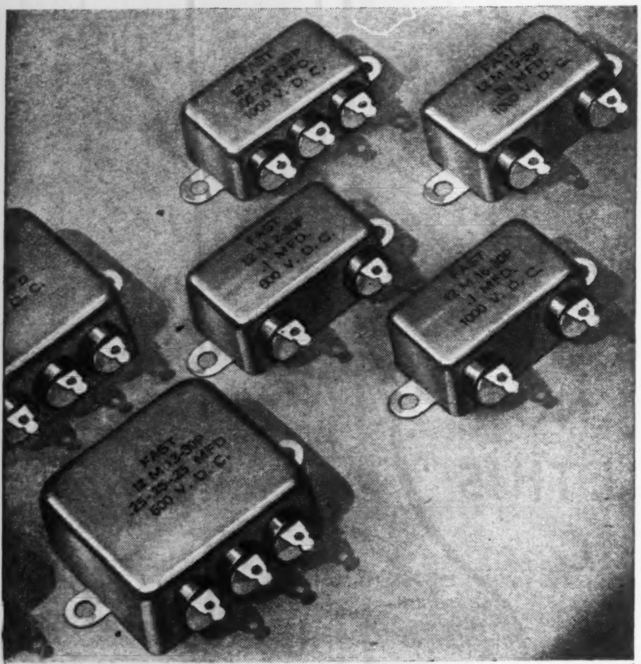

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by the arrow will change the effective area, and therefore if the applied plate potential is maintained constant, the current flowing will be limited by the space charge, and its magnitude will vary linearly with the movement.[318]

Both forms of the movable-electrode tube have been found to be robust and sensitive, and can be made to withstand moderate amounts of vibration without damage.

Another form of electron tube designed for control by external phenomena is the deflection-beam cathode-ray tube which contains, instead of a fluorescent screen, two (or more) electrodes upon which the beam impinges. It therefore is a relay, with the electron beam acting as the current-conducting element. The beam may be deflected by electrostatic, electromagnetic or even purely magnetic means as shown in Fig. 135; and the tube is especially suited to installation in an amplifier circuit which can provide an output current varying with the beam position.[319,320] The amount of current carried by the electron beam varies with the area of the beam intercepted by the target, so that the variation in beam current with beam position is continuous; the beam current is only a few microamperes, however.

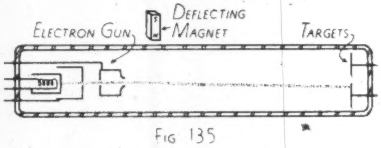

Fig 135

A somewhat similar tube has been used for multi-circuit switching purposes at high speed, and eliminates difficulties with contacts and inertia of moving parts.

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(318) E. D. McArthur. Movable-Anode Tubes. *Electronics*, Vol. 10, March 1937, pages 16-17.

(319) H. Ziebolz. U. S. Patent No. 2,314,302. Mar. 16, 1943.

(320) Paul Glass. Deflection Beam Tube. *Electronic Industries*, Vol. 3, August 1944, pages 90, 93, 202, 204, 206.

ELECTRONIC MECHANISMS

Continued from Page 233

effect of a regulator on plate current change with line voltage will be discussed later. See Fig. 18.)

Fig. 11, a simplified drawing of an industrial form, shows the measuring instrument carrying upon its pointer the control flag. The "control coils" (the inductors L_a and L_b of Figs. 5 and 6) are mounted upon a setting arm whereby relay operation can be made to occur at any desired point on the scale. A pointer stop mounted on this setting arm

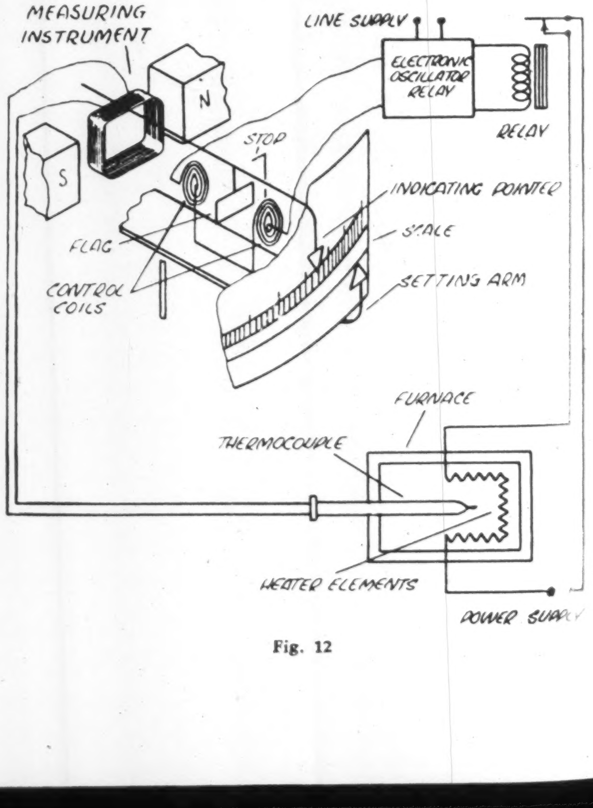

Fig. 12

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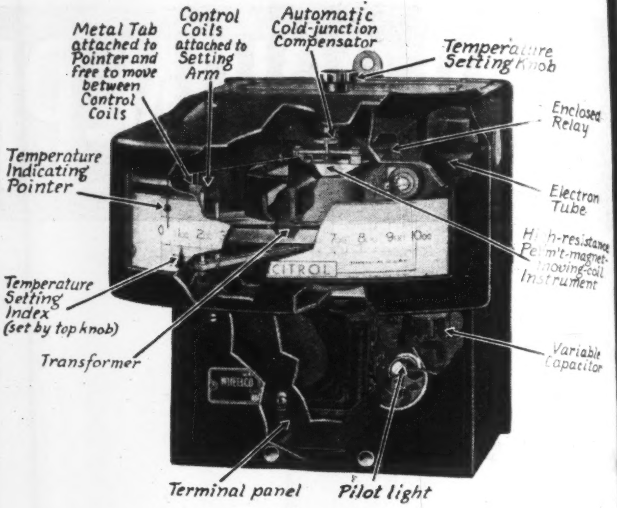
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Temperature Setting Index (set by top knob)
Transformer
Variable Capacitor
CITROL
Terminal panel
Pilot light

Fig. 13

prevents the pointer from passing beyond the setting zone: this is to prevent the flag from passing completely out of the field of the control coils and thus destroying the normal function of the control mechanism. Suitable flexible leads connect the movable control coils to the oscillator unit inside the case of the automatic-control instrument. Fig. 12 shows the Fig. 11 components adapted to a pyrometric control system in which the electrical measuring instrument is a millivoltmeter energized from a thermocouple in the controlled furnace. The heating elements are under command of the relay contacts, the off-on operation being obvious from the illustration. The physical appearance of industrial components is brought out in the annotated photographic illustration, Fig. 13.

ELECTRIC MOTORS

Continued from Page 219

ing to some arbitrary system of classification, such as physical size, historical development, or by any other association of ideas that furnishes a flight of stairs up which the imagination can step from one motor type to another. Now suppose that on the other side of this chart we have a somewhat similar classification of instruments, let us say starting from some of the most important, and therefore some of the oldest, types, on down through commercially less important instruments to highly specialized scientific apparatus and on into the realm of equipment lying within the limits of process control apparatus.

Now, supposing that we have this chart with motors classified on one side and instruments and control apparatus classified on the other side, it becomes apparent almost at once that practically any motor can be connected by lines on the chart to almost every piece of apparatus. Conversely, almost every classification of apparatus could be connected by lines indicating its dependence in some form or at various times on almost every type of motor.

Faced with such a complex picture, we have chosen to avoid any attempt to completely interrelate the field of motors and motive power devices on the on hand, and the field of instruments and control apparatus on the other hand. Rather, we present in each individual classification practically the complete range of apparatus involved, there being of necessity many individual gaps between the extremes—between the top and bottom of each classification list. The field between these two lists is a field of imagination, to be filled in and related by the special interests of each reader.

We believe, nevertheless, that the picture as presented will simulate constructive thinking as to the mutual needs

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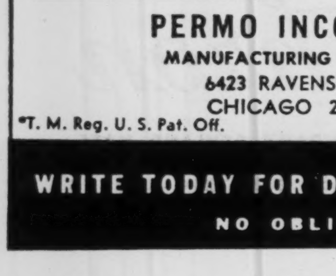
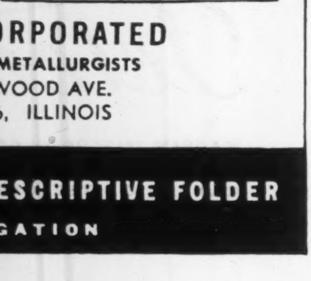

Ordinary pivot after test


Permopivot after test

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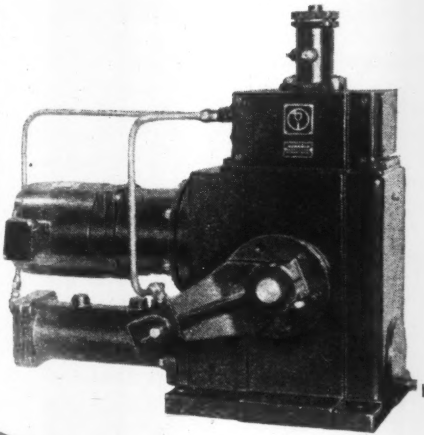

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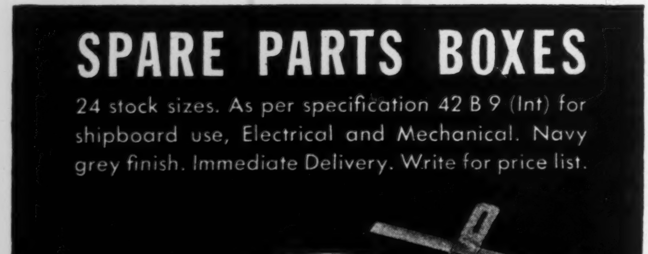

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of the apparatus manufacturers on the one hand and the problems of design, production and supply of the manufacturers on the other hand.

MOTOR CLASSIFICATION GROUPS

1. Hysteresis Type Synchronous Motors

In the Warren Telechron design, these motors are similar in certain general respects to the small shaded-pole motors so often employed for driving low-priced fans, in that they have usually a rectangular core structure with a form wound coil placed on one leg, while the rotor occupies a space in the opposite leg. This design in its simplest form provides a two-pole field structure. Shading coils are provided, which furnish the necessary rotating field flux. Small light steel members constitute the rotor and are so designed as to operate synchronously with the alternating current. Because of its bipolar construction, the rotor operates at 3600 r.p.m., so that for operating speeds of 1 r.p.m. output on the end of the gear reducer shaft a nest of spur gears in a 3600-to-1 ratio is used. Lower gear ratios provide higher output speeds. The complete motor and gear train are contained in a sealed assembly provided with a supply of oil and means for conducting this oil to all the moving parts in the assembly. These motors are rated in watts input and torque output. The largest size made requires 12 watts input with 2 inch-pounds torque at 1 r.p.m. output. These motors are available for one direction of rotation only, in reversible types, and several designs have been provided with totally-enclosed explosion-proof cast bronze cases. Some of the types are re-oilable. The motors are made in three types for light duty, medium duty and heavy duty.

In addition to their line of motors, Warren Telechron Co. also manufacture for sale separately the small gear reducer units which they regularly use with their motors. They also manufacture time control systems and electric clocks.

The Haydon Mfg. Co. manufacture a small timing motor, also described as a shaded-pole hysteresis synchronous motor. It differs fundamentally from the Telechron motor in that the field structure is not bipolar but multipolar. This is accomplished by use of a small form-wound coil placed in a magnetic cup-shaped structure arranged so that the upper edge of the "cup" ends in a series of fingers forming magnetic poles. The shading coil consists of a ring punched out so as to encompass every other pole. By this means, together with a hardened steel ring which is magnetized and supported on a light aluminum spider as the rotor member, they obtain synchronous operation at the low speed of 450 r.p.m. Thus for 1 r.p.m. output a 450-to-1 spur gear train is used. The entire motor is in a sealed case, provided with a supply of lubricant which is fed to all the gear shafts and to the principal motor shaft by special means providing long life.

The motors are rated from 2 to 4 watts and are obtainable in reversible types and a variety of output speeds. Explosion-proof types are also available.

Several interesting developments have been added to these Haydon motors. These include magnetic clutching and declutching of the rotor pinion gear with its gear train, combined with an overriding clutch on the output gear shaft. Such units are especially applicable to time-delay relays used for preheating vacuum tubes before applying plate voltage. In this capacity they are used to operate small switches at a predetermined interval of time after the current is applied. At the limit of the motor's travel, when the switch to the plate circuit is closed, the motor remains stalled in this position. With any interruption of the current, the rotor, which is held in its normal operating position by reason of the attraction of the magnetic field, is released and a counterbalanced arm which exactly balances the rotor weight and is equipped with a small spring, presses on the end of the pinion gear and thrusts it out of engagement with its gear train. The purpose of the counterbalanced arm is to permit operation of this declutching device no matter what position the motor is in.

As soon as the rotor has been declutched, a spring on the

HAYS
COMBUSTION TEST SET

Engineers EFFICIENCY ANALYSIS

SERIES 3000

TEST SET

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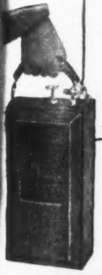

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SIZE OF CASE
7⅞"x5"x15" HIGH
WEIGHT 9 LBS.

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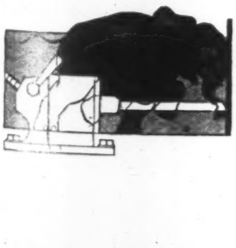

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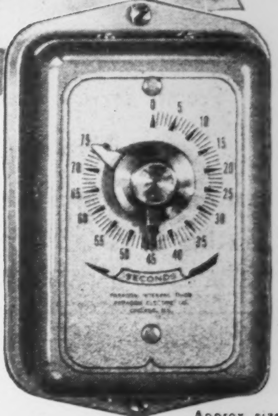

Approx size of 800 Series, 4⅜" high, 2½" wide, 1⅞" deep.

PROTECT IT WITH *Paragon* TIME DELAY RELAYS

NOTHING is more vital to the war production program than electrical equipment. Guard it with Paragon automatically reset, synchronous motor operated time delay relays, which:

1. Protect rectifiers and tube filaments from application of plate current before filaments are preheated.
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Accuracy of the time cycle and operation of the timer not affected by changes in ambient temperature or vibration. Designed for panelboard mounting or may be mounted to standard handy box or single gang switch box.

Built by an organization of engineers and skilled craftsmen specializing on electrical equipment since 1905. Write for a bulletin on 800 Series Time Delay Relays.

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726 OLD COLONY BUILDING
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BUILDERS OF ELECTRICAL EQUIPMENT

output shaft will spin the gear train back to its original starting position, which, of course, opens the switch and plate circuit. This spring has power enough to rotate the gear train backwards to its starting position but would not have power enough to spin the rotor as well. At the limit of travel, the gears have sufficient energy to deliver an unwelcome impact blow, and at this point the overriding clutch on the output gear shaft functions to permit the gradual absorption of this energy. Thus, while the output shaft stops abruptly, the gear train is not stopped abruptly, its energy being absorbed in the friction of the overriding clutch.

These clutches on the output shaft are provided as true overriding clutches or as simple friction drives. Both of these devices permit various forms of manual resetting, or can act to protect the motor from damage due to sudden loads that might be applied to the output shaft.

Another unit provided for control of these small motors is a magnetic brake. These brakes stop the rotor instantly and prevent coasting after current is turned off. They are used in such applications as elapsed time indicators.

The Hansen Manufacturing Company, Inc., manufacture the Synchron line of small synchronous motors. These motors are somewhat similar in construction to the Haydon motors. Leich Electric Co. also manufacture motors of this general type.

Small synchronous motors of the types referred to above have a very wide variety of uses, not all of which are in the instrument and control apparatus field. A partial list of applications in the instrument and control apparatus field is as follows:

Airplane wing light flasher
Apartment hall light control—Time switch
Attic fan control
Automatic coal stoker control
Automatic dishwasher timer
Automatic oil burner control
Automatic radio program timer and selector
Automatic and remote reset clock system for office and public buildings
Automatic telephone toll call register
Bell ringing equipment—on a time schedule
Busy signal impulse timer for intercommunication telephone
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Control Instruments—Time delay relays and repeat cycle timers —Electric furnaces, process timers, pasteurizing equipment, etc.
Crystal receiver protection—Time delay relay
Day and night thermostat
D-c. Potentiometer drives
Elapsed time indicators
Electric fence timers
Electric range timer—Automatic heat shutoff
Electric off-peak load timer
Electrocardiograph
Exposure rate governor for X-ray equipment
Incubator timer—turns eggs
Interrupter—times impulses to electromagnetic counters for counting or telling time
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Polarity changer for rectifier
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Time Delay Relay for Protection of Vacuum Tubes—X-ray equipment, welding equipment, rectifier, radio and Radar transmitters and receivers
Variable-frequency timing mechanism

2. *Salient-pole Synchronous Motors*

In the same classification as to size with the hysteresis synchronous motors has been an even smaller motor using a squirrel-cage rotor which in some cases has been as small as ⅜" in diameter and approximately ⅜" long, mounted in a bipolar field equipped with shading coils. This motor operates at a subsynchronous speed. That is, instead of operating at the basic speed of 3600 r.p.m. for a two-pole motor, the rotor "crawls" at a much lower speed. These very small units have been used by manufacturers of maximum demand meters in order to drive a pointer over the scale for a fixed time interval which is continuously repeated, thus giving an indication of the maximum demand in terms of the integrated power taken during such time interval.

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MIRRORS
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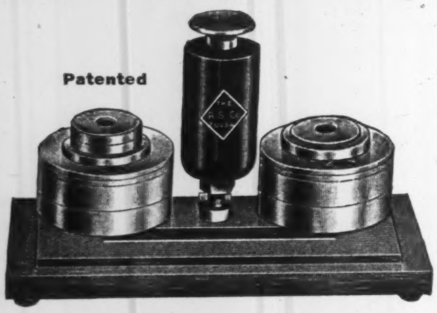

This device will measure any gas pressure to a **higher degree of accuracy.** It does not have to be handled gently. It never has to be checked or calibrated. Weights are brass, stacked on posts on same base as the tester. Available in Standard and High Pressure models. Delivered complete with weights and hardwood carrying case. Standard ranges; 5 to 300, or 500, or 1,000 p.s.i.

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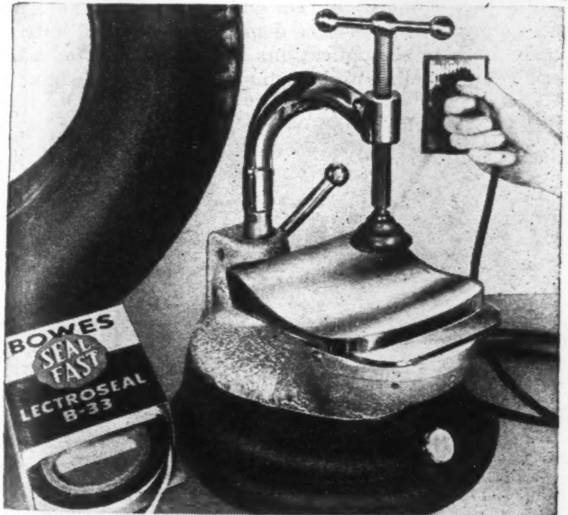

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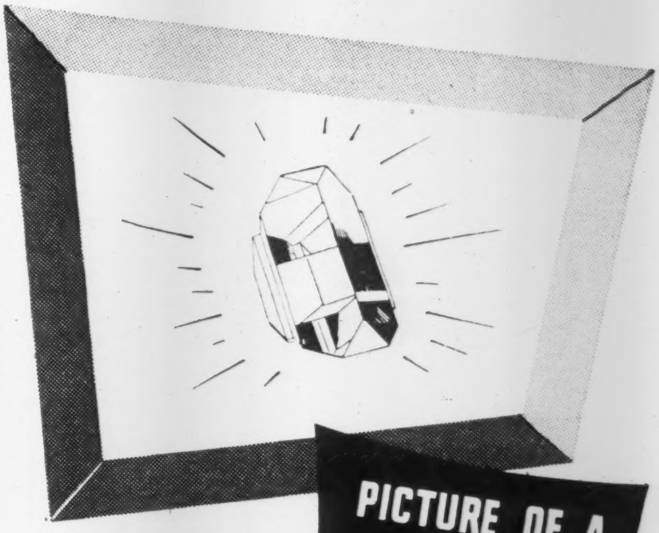

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THIS jewel-like SOMCO Roof Prism is destined to play an important part in the postwar plans of many manufacturers.

It is just one of numerous SOMCO precision optics—optics that are now at war—optics that will be broadened for peacetime use, far beyond their present military application.

SOMCO engineers are taking full advantage of their wartime experience to give the optical industry finer precision optics than we produced before. Just as soon as our war job is completed, SOMCO products will be back—back to help you create new and finer products for new and wider markets.

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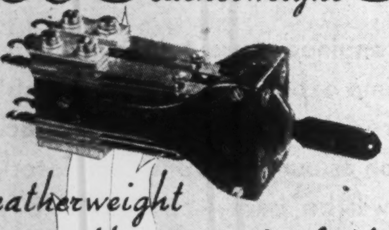

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- Amperes AC 10 Volts 115
  DC 2

Contacts may be ganged in any desired number and combination and for locking or spring return in either lever position.

METALLIC ARTS CO.
243 Broadway
CAMBRIDGE 39, MASSACHUSETTS

3. *Shaded-pole Induction Motors*

Shaded-pole induction motors of the well-known bipolar construction with a rectangular core similar to the unit manufactured by the Barber Colman Co. are now made by a large number of manufacturers. These motors are used for a variety of purposes, but in the instrument and control apparatus field their greatest use has been to operate damper controls on combustion systems, though they are also used to drive fans and blowers for cooling vacuum tubes, booster furnace fans, various types of valves used for gas, steam or water, program switches, temperature regulators, time-delay contactors and miscellaneous laboratory devices.

Such small shaded-pole motors are made in unidirectional, reversible and gearhead models.

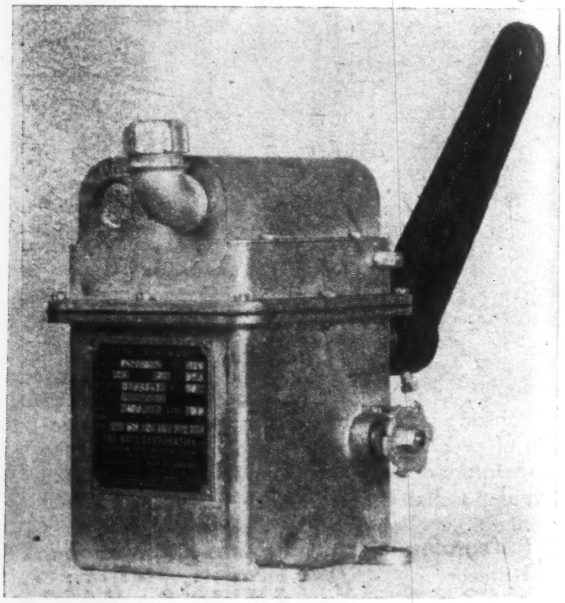
Practically every manufacturer of fans has manufactured a motor of this type for his own use, and many makes are on the market, including such other manufacturers as A. G. Redmond Co., The Alliance Mfg. Co., F. A. Smith Mfg. Co. and many others.

Shaded-pole induction motors are made by a number of motor manufacturers in larger sizes, which generally do not use bipolar cores but employ more conventional styles of stators, usually in four-pole construction. Some shaded-pole motors are manufactured in sizes up to 1/30th horsepower at 1800 r.p.m. In such sizes they also find use for the operation of dampers, fans and similar equipment.

Shaded-pole induction motors are extremely simple in construction for single-phase motors, as no centrifugal cut-out switches or fine-wire starting windings are employed, and no external capacitors or other devices are required with them. From that standpoint they are practically indestructible. In the smaller sizes they are generally constructed with oil-less bearings, and the lubrication system is of somewhat limited capacity.

The speed-torque curve of such motors is a continuously sloping one. They develop their maximum torque in the stalled position. Because of the sloping speed-torque curve characteristic, they are quite well suited to fan and blower applications where the power required varies as the cube of the speed. For such applications, a motor with such speed-torque curve will run at fairly constant speed.

Where they are used in connection with damper controls, valve controls and other similar applications, they are inevitably equipped with gears which are frequently assembled with the motor by the manufacturer. The Barber Colman Company, to meet the demand for rugged, unfailing service in industrial applications of this type, offer a complete power-controlled unit, which consists of motor and



Barber Colman power-controlled unit used by the Hays Corporation as part of their combustion control system.

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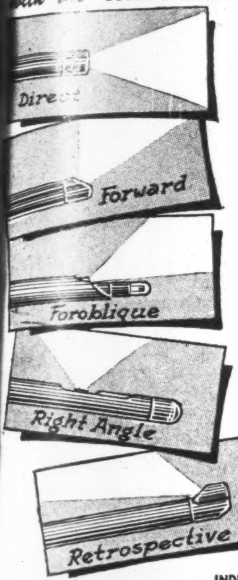
OR
SEE AROUND A CORNER!
with the WAPPLER INDUSTRIAL TELESCOPE



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EXAMINATION OF
INTERNAL SURFACES
may be solved by means of

WAPPLER BORESCOPE

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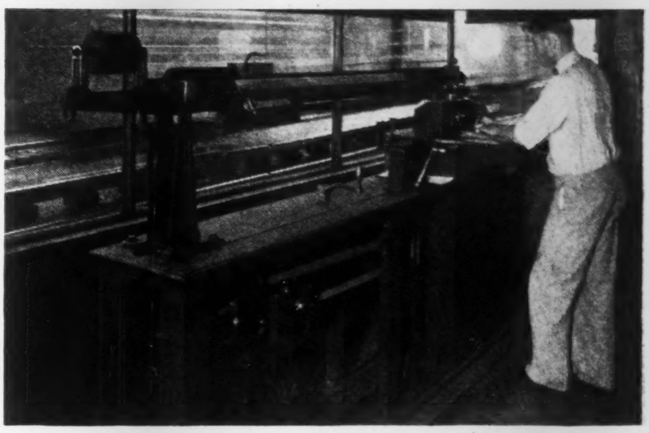

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IN AUTOMATIC WEIGHING

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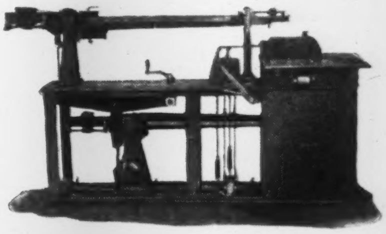

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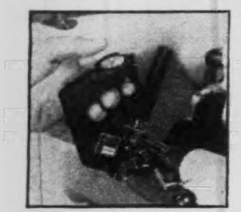

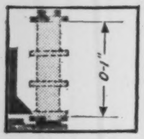

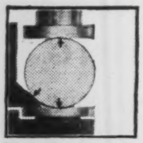

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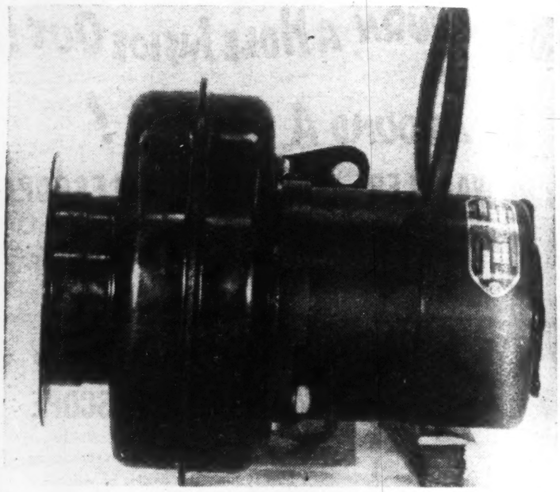

Delco Appliance Division, General Motors Corporation, shaded-pole induction motor driving centrifugal blower.

gears enclosed in a die-cast housing with gasketed cover, the entire motor and gear unit operating submerged in oil. The output shaft may drive a crank arm, as illustrated in the accompanying view.

A typical shaded-pole motor drives a blower used for cooling vacuum tube installations. Manufactured complete by Delco Appliance Division, General Motors Corp., as illustrated herewith.

4. A-c. Motors with Distributed Wound Stators

In this group of motors, the thing which distinguishes them from any of the types previously mentioned is the fact that they employ multitoothed stators with distributed windings. They are made in a variety of types, both synchronous and non-synchronous.

The means of starting the smallest of these single-phase motors is usually a split-phase winding, or a capacitor winding. The smallest of these units measure in the neighborhood of 1½" outside diameter over the stator laminations. Regardless of this fact, some of them have even been wound for three-phase current. Essentially, three-phase windings are used where stators of this size are employed in the construction of synchros, which will be discussed later. Likewise, high-cycle motors, such as the 400-cycle motors now used on aircraft and in small portable tools, employ these very small stators.

The smallest units used to any extent in the field of instruments and control apparatus are the Bodine Type K, and the equivalent motor manufactured by Holtzer Cabot Electric Co. The Bodine unit measures 2⅜" across the flat sides of the motor. They are furnished in single-phase synchronous and non-synchronous types for use with an external capacitor. Such motors are regularly furnished with integrally mounted spur gear reduction units when required. Their ratings at the high speed shaft are approximately 1/50 h.p. maximum at 1725 r.p.m., 60 cycles, to 1/40 h.p. at 1725 r.p.m., 60 cycles, in the non-synchronous types.

Since one of the general requirements for such motors when used on instrument applications is quick stopping, some of them are provided with special windings which permit of shorting out the capacitor, thus putting full-voltage single-phase current on both of the two-phase windings, which dynamically brakes the motor. Where this braking action is required, it is necessary to reduce the non-synchronous output rating to one-half what it is otherwise, at a somewhat reduced speed of about 1200 r.p.m.

The importance of a motor designed specifically for the job it is to do cannot be overemphasized. General-purpose electric motors as manufactured by a number of different firms represent in their design and construction a compromise between all the various performance factors involved. Then when a specialized application is encountered which requires a different type of winding, it is customary

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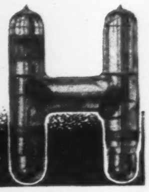

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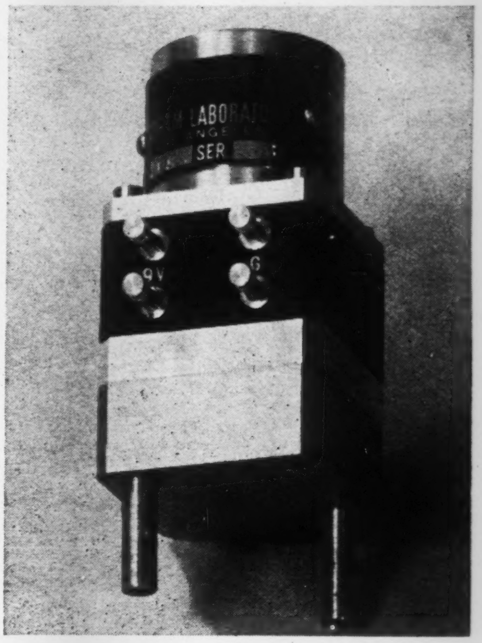

These remote indicating pressure transmitters are designed for indicating and recording dynamic and static pressures of air or liquids. They are normally made in pressure ranges of ½-0-½ p.s.i. to 15-0-15 p.s.i. Other ranges can be supplied on special order. The sensitive element of these pressure transmitters employs the unbonded strain sensitive filament technique developed by Statham Laboratories in collaboration with the Research Laboratory of the Curtiss Wright Corp. Strain sensitive filaments are mounted in grid form to make up four active arms of a Wheatstone bridge. The bridge is connected and permanently balanced inside the instrument. Four electrical terminals are provided. A small dry cell battery is connected to two of these terminals, while the other two terminals are connected directly to a galvanometer recorder, a 0-100 microampere panel type meter, or a standard recording potentiometer.

The natural frequency of these pressure transmitters is approximately 1000 cycles per second. Temperature stability is inherent in the instrument because of the symmetry of its four active bridge arms. The complete instrument measures 1¼" x 1¼" x 2½" and weighs about 3 ounces.

The chief point of superiority of this pressure transmitter is the ability to record aerodynamic and fluid pressures, both dynamic and static, without vacuum tube equipment of any kind. So far as we know, there is no competitive device which will perform this service.

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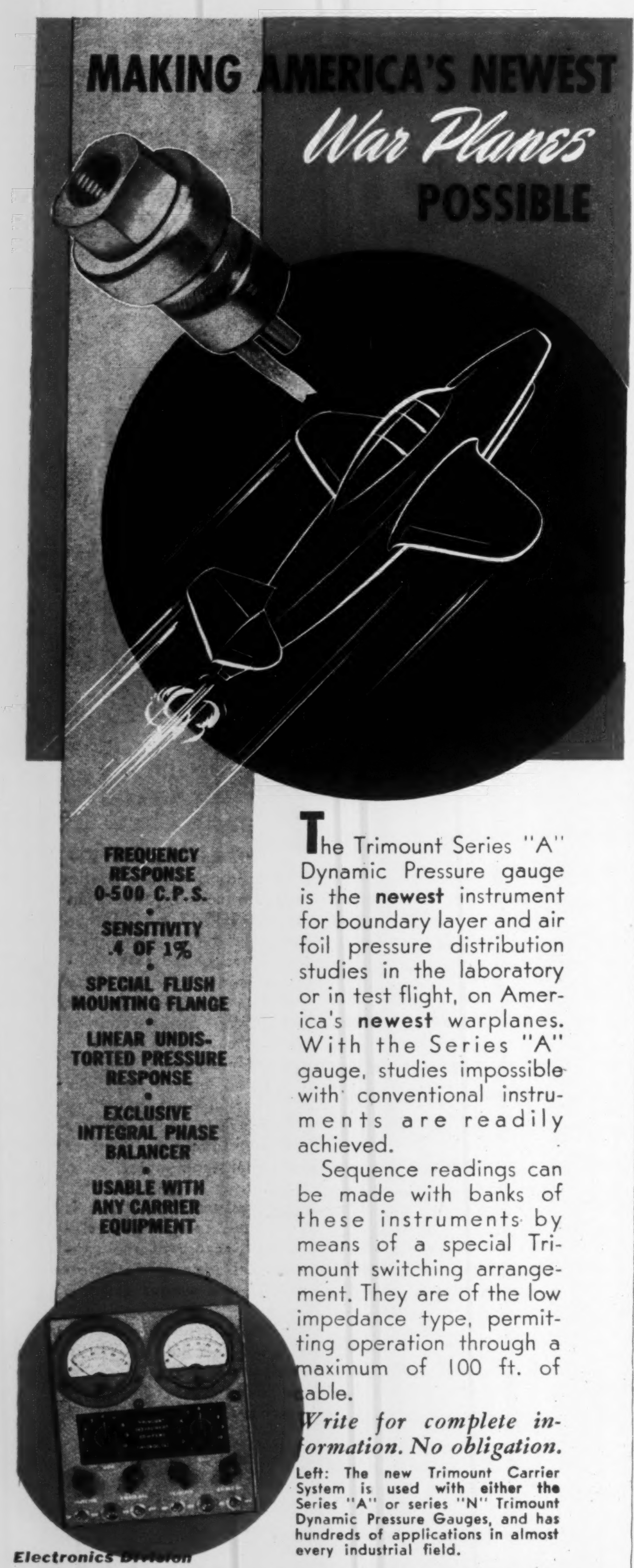
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Electronics Division
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to take the standard motor frame and, in extreme cases, change the length of the stacking, and in many cases where this is not done, to take standard stackings and modify windings. Some modification may also be made in the rotors, though this, aside from a change in length of stacking, is less probable. When such changes are made, something short of ideal performance for a particular instrument application is very likely to result. An illustration of this is an analysis of the moment of inertia of the rotor versus the starting torque of some small synchronous power motors which were designed as capacitor start and run units. By comparison with the same data for a capacitor start and run motor of larger size, which, however, had never been designed originally as a capacitor start and run motor, we find that many of the performance characteristics are considerably different and the moment of inertia of the rotor is about twice as great in proportion to the starting torque as in the case of the smaller motor which had been designed specifically for capacitor service. Here again, the starting torque would be related to the full-load rating and that would in turn depend on such factors as the ventilation provided for a given motor.

Because there has been developed by some manufacturers such as Sperry Gyroscope a low-inertia motor having, in their case, a ⅝″ diameter rotor which is about 2½″ long, in an effort to obtain high operating torques with a small moment of inertia for quick starting and stopping, it cannot be assumed that merely lengthening the stacking of a motor will give the desired performance. In a certain standard line of capacitor-start induction motors, we find the following data:

Rotor Diameter Inches	Rotor Length Inches	Type Frame Size	Moment of inertia of rotor, in. oz.	Capacitor motor hp. at 1725 r.p.m.	Starting Torque In.oz.	Starting Torque % of FL	Ratio of St.Torque toM.ofI.
1.25	9/16	K-22	0.0210	0.010	1.1	183.0	52
1.25	11/16	K-23	0.0258	0.0133	1.4	175.0	54
1.60	1-3/8	N-12	0.1532	0.020	13.5	112.5	88
1.60	1-3/4	N-13	0.1953	0.025	10.5	70.0	54
2.00	1-5/16	N-33	0.400	0.050	32.0	108.6	80
2.00	1-13/16	N-34	0.554	0.067	37.5	96.0	66
2.00	2-13/16	N-35	0.856	0.082	39.0	81.2	45
2.75	1-1/8	N-53	0.823	0.082	43.0	89.5	52
2.75	11/16	N-54	1.192	0.125	60.0	80.0	50
2.75	1-11/16	N-54	1.192	0.125	60.0	80.0	50

5. *Electronic-controlled Motors*

Coincident with our consideration of these smallest distributed-wound stator type motors, it is pertinent to consider some of the characteristics of motors used in connection with electronic controls. While it is possible, of course, to operate commutating type motors by electronic control, most of the applications so far developed in these small units have involved the use of a-c. distributed-wound stator types.

Motors which receive their power through vacuum tubes have to be higher in efficiency than ordinary motors of comparable size and rating. The reason for this is obvious. Since the current for these motors must be supplied by the tubes, the efficiency of a motor has a direct bearing on the size and cost of the tubes used to supply it. To secure this higher efficiency, special design is necessary. Air gaps must be very close and held very concentric, necessitating extremely close limits in machining operations. Some cases may even necessitate selective assembly. Due to these very careful procedures, it may be expected that the cost of producing motors for use in connection with electronic control is likely to result in much higher prices for them than for the ordinary run of good motors.

The moment of inertia of the rotors is of consequence in current types of electronic control, calling for quick starting, quick stopping and quick reversing.

There is in connection with electronic control an increasing use of a two-phase motor with electronic phase shift and voltage control applied alternately to the two windings through a capacitor so as to secure speed control, reversibility and quick stopping. Such a system of control will be described later, in discussing motor applications. Bailey Meter Co. uses a system of motor control similar to this.

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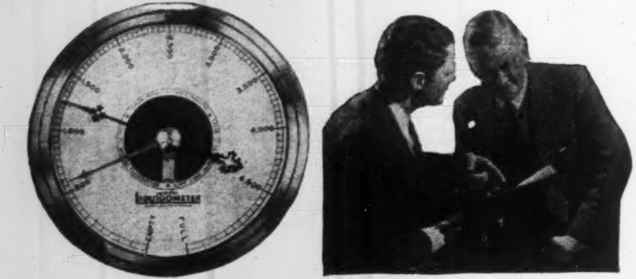

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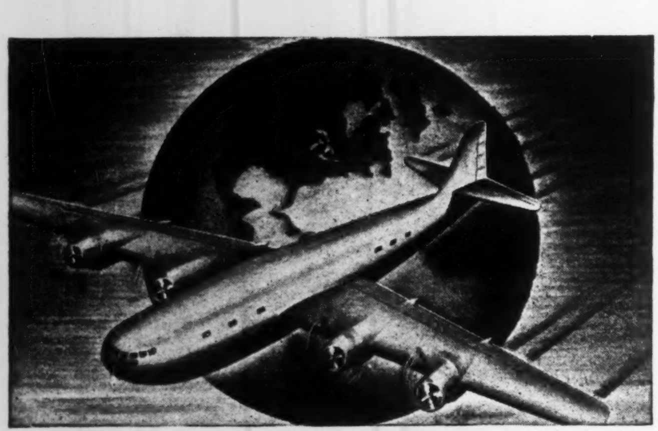

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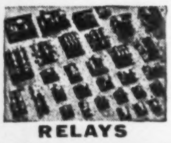
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reversible brushless motor operation with a speed range of 10 to 1 in either direction is by two synchronous motors feeding into a mechanical differential in opposition to each other, so that if both are rotating at 1800 r.p.m. the output speed is zero. If one of these motors is frequency controlled from an oscillator which could change its speed, say, from 1790 to 1810 r.p.m., it becomes obvious that at 1790 r.p.m. the output shaft speed from the differential would be 10 r.p.m. in one direction, while at 1810 r.p.m. the output shaft speed would be 10 r.p.m. in the reverse direction. Such a hookup would provide variable speed over the required range, with reversibility. The distinction between this system and that of the electronic two-phase motor control used by Bailey Meter Co. is that in this electromechanical system the output torque on the drive shaft would be the equivalent of the full-load output torque of both motors minus the losses in the differential. This output torque would be relatively constant over the entire speed range of the differential output shaft. Thus we would have a constant-torque variable-speed variable-horsepower output. With the electronic system used by Bailey Meter Co., the output torque is related to the output speed, increasing with the speed, though not in direct relation thereto. The stalled torque of this system is relatively high, being about 80% of the full-load torque, but the running torque at low speed is low and increases as the phase displacement and magnitude of the currents in the two windings changes.

To be Continued

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By JAMES SPENCER, in charge of Instrument and Relay Dep't, Westinghouse Elec. & Mfg. Co., Newark, N. J.

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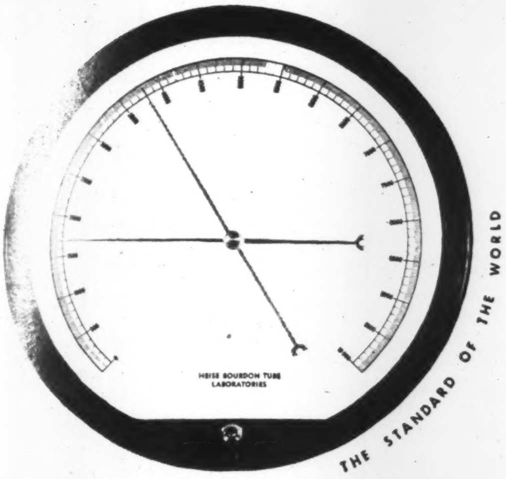

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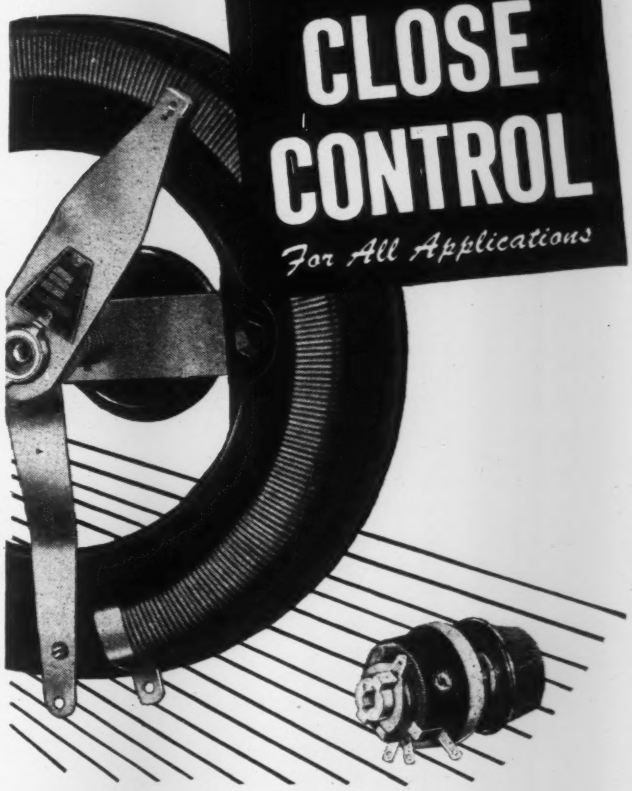

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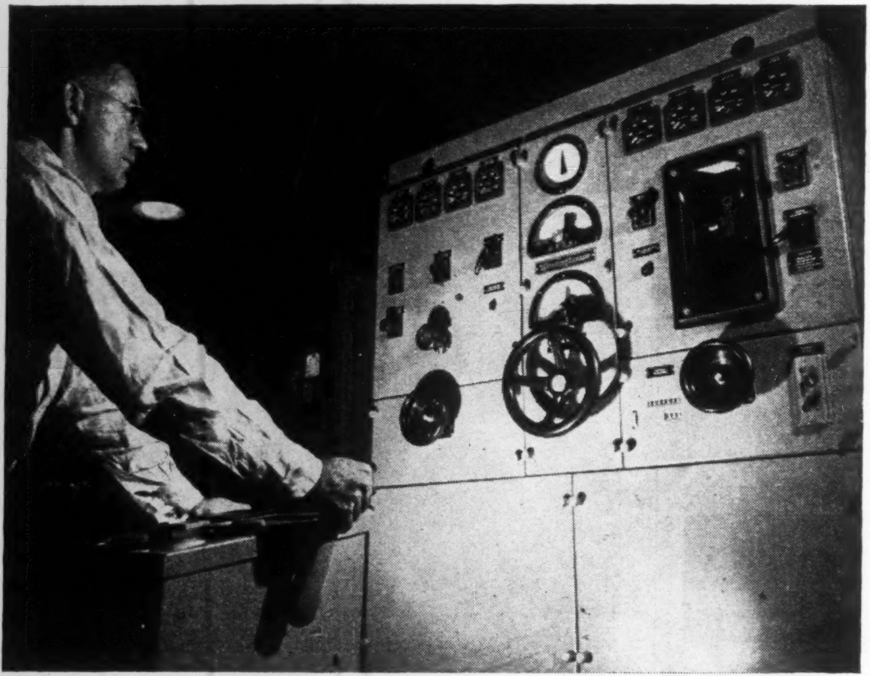


New Electrical Control for Single-screw Vessels

PITTSBURGH.—Disclosure has been made of the first electrically-operated power control for a-c. turbine-electric-driven Navy ships. The new system makes control of the vessel's motor as simple as the flicking of a light switch. It "brings the complex electric motor equipment of the ship under the direct command of the man at the pilot house control," said Walter Schaelchlin, marine control engineer of the Westinghouse Electric & Mfg. Co.

The system, which includes a small control stand in the pilot house and a main control board in the engine room, is designed for regulating the speed and the forward or reverse direction of the electric motor which powers the ship. The only motion needed to control the ship's motor is the movement of the lever at the side of the control stand.

Under standard operations for such ships, a signal is sent from the bridge by the engine-room telegraph; the engine-room crew confirms the signal and then, by operating a series of control levers, carries out the pilot's command.

The new unit eliminates the time lapse and the possibility of human error. It gives the pilot a tremendous advantage in maneuvering a ship.

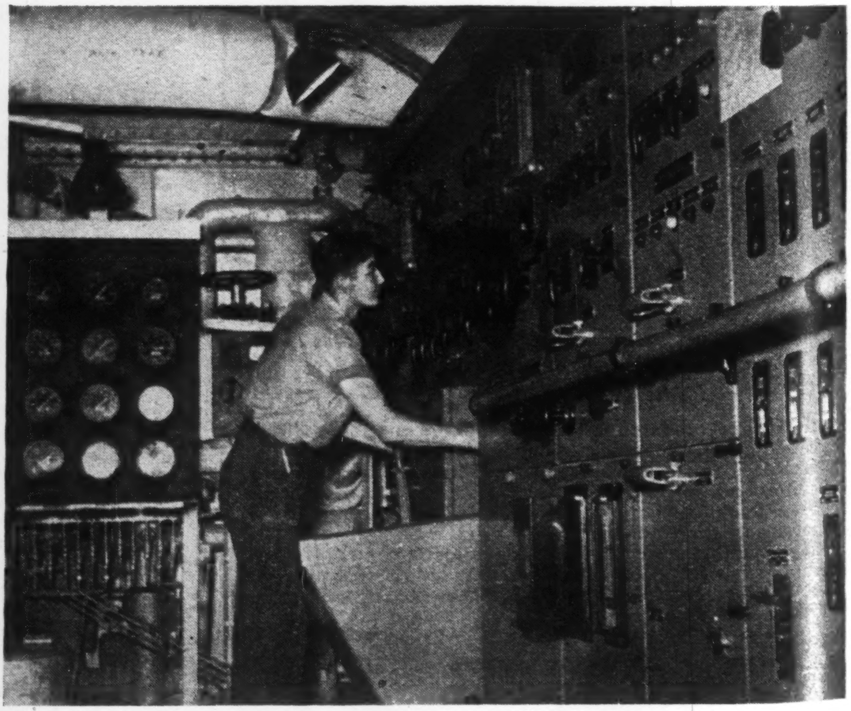
The device, designed by Westinghouse in collaboration with Coast Guard engineers, regulates the flow of energy from the steam turbine to the generator for control of speed, and through a series of switches controls the forward and reverse direction of the motor. The above photograph shows it undergoing tests at the factory.

New Electrical Control for Twin-screw Vessels

PITTSBURGH. — Turbine-electric propulsion gives the new Navy attack transports excellent maneuvering characteristics with full power ahead or astern, making for short stopping time and quick reversal of the ship, according to S. L. Lindbeck, Marine Engineer of the Westinghouse Electric & Mfg. Co. Use of electric drive also permits inter-connection to drive both screws from the generator in one engine room.

The ships are twin-screw, each propeller being driven by a 3300 hp., 165 rpm. synchronous motor. Two propulsion turbine-generator sets operate at 4950 rpm., and thus the speed reduction ratio obtained is 30 to 1. For normal operation each motor is driven by a separate generator and is completely independent of the other. For cruising at reduced power, the two motors can be operated from either one of the two generators. Under this condition the two screws are maneuvered as one, since they must operate at exactly the same speed and in the same direction. The speed of the propellers is varied by speed control of the turbine, the electrical system giving a fixed speed ratio determined by the ratio of the number of poles on the motor and generator, 60 and 2 respectively. An electric drive permits the main turbine to be built for one direction of rotation and gives equal power ahead and astern. This is of particular advantage in maneuvering the ships. Reversing the screws is accomplished by switching electrical connections.

The photograph below shows a seaman at the propulsion control panel operating the starting and speed control



levers. The main turbine is directly behind the operator where it is easily accessible. The turbine gage board seen to the left of the operator has all main propulsion turbine gauges. A salinity indicator is to the right of the gage board.

The propulsion control cubicles, one in each engine room, provide centralized control of the main turbines, generators, motors and their auxiliaries. The three levers on the desk start and stop and control the direction and speed of the propeller. The left-hand lever controls the reversing and field switches. It has a START and RUN position in the ahead and astern direction. In the START position, the motor is connected to the generator, and the generator field voltage is raised to maximum value, starting the motor as an induction motor. When the motor has been brought up nearly to synchronous speed, the lever can be put in the RUN position, where the field voltage is applied to the motor, pulling it into step. A time delay relay in the generator field circuit operates shortly after the RUN position is reached, reducing the field voltage to normal running value.

The middle lever on the operating desk controls the turbine governor speed setting.

The right-hand lever controls the stop on the turbine governing valve mechanism, preventing the valves from lifting more than a definite amount.

An interlock between these three levers prevents changing the position of the starting lever unless one of the steam levers is in the SLOW position. This prevents the load from being removed from the turbine unless the turbine valves are closed or the speed setting is reduced to idling speed.

The left-hand handwheel on the panel operates selector switches to permit operation of the two propulsion motors from either main generator. The right-hand handwheel transfers the excitation circuits from the local to the standby exciter set. Two methods of excitation control are available; one is automatic stability regulation in which the field current of the motor and generator is varied in proportion to load. This is the normal method and allows the use of minimum sized main electrical machinery, short-time overload being carried by increasing the field excitation of the machines. Propulsion motor voltage and current are used as a measure of propeller load, and d-c. currents obtained from these by means of a Rectox rectifier are applied to two fields of a Rototrol pilot exciter. As current and voltage change with load, the field voltage is raised or lowered as required. This Rototrol generator is a part of a small motor-generator set which also supplies constant voltage d-c. power for control relays and indicator lamps.

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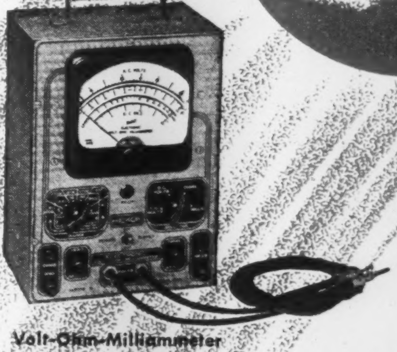
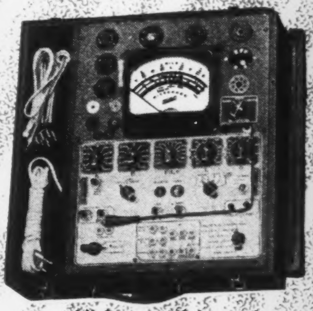


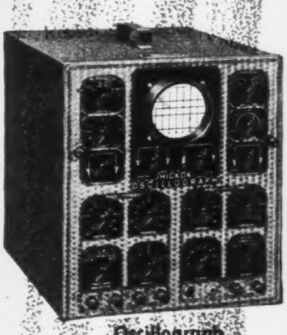
Volt-Ohm-Milliammeter



All-Purpose Tube and Set Tester

HICKOK
BAND SELECTOR
SIGNAL GENERATOR

Signal Generators



Oscillograph

ELECTRONIC

and

RADIO SERVICE

Equipment

HICKOK Instruments have long been known as the ultimate in scientific development. Illustrated here are but 4 of our 36 leaders in the Radio Service field. Thousands of Radio Service men have preferred HICKOK Instruments because of their unusual accuracy and dependability. • HICKOK pioneered in Dynamic Mutual Conductance Tube Testing Equipment. In the field of Signal Generators, Traceometers, Vacuum tube Voltmeters, Oscillographs, Zero Current Testers, Volt-ohm-milliam-meters and Industrial Analyzers the name HICKOK is assurance of excellence.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10519 Dupont Ave., Cleveland 8, Ohio

ports. In addition, there are a large number of lighting and power panelboards. The generator switchboard is located adjacent to the propulsion control board in the after engine room. A power supply of 450 volts is used for all a-c. power application, and 125 volts a-c. is used for lighting and small accessory loads. A 200-kw. 250/125-volt d-c. power system provides power for cargo winches, boat hoists, degaussing, searchlights, and other d-c. requirements. The d-c. generator and distribution panels are a part of the forward and after engine room switchboards. There are four generator switchboards for the forward-after auxiliary and emergency generators. There are two distribution switchboards, one forward and one aft. Other switchboards are the interior communications, steering power transfer and battery charging and discharging switchboards. A testing switchboard is also installed for electrical maintenance work.

American Radiosondes Surpass Enemies'

WASHINGTON.—This country, our allies and our enemies, in order not to be at a serious disadvantage in fighting the war, check the weather in the stratosphere by means of radiosondes. For America the U. S. Army Signal Corps is charged with this responsibility, as a part of its meteorological service.

Enemy radiosondes have been captured and carefully studied and this provides interesting comparisons between our own and those of Germany and Japan. In general it may be said that German and Japanese radiosondes give fewer readings than those developed by America and therefore are less accurate. They are well built and well designed, and are smaller in size and lighter in weight than American instruments. In one notable way they are inferior to ours: neither the German nor the Japanese instruments are designed for mass production as ours are. Their mercury thermometers and manometers are not suited for mass production since certain component parts can be made only by hand, and at least two precalibrations are necessary.

German and Japanese radiosondes make use of techniques and measuring elements similar to those used in American instruments, but they differ in the types of such elements employed and in the method of varying the transmitted signal.

The Germans have two types of radiosondes in general use. The first type employ wet- and dry-bulb mercury-in-glass thermometers for measuring temperature and relative humidity, and a mercury-filled glass manometer for the determination of pressure. These glass tubes have metallic coils on the outside distributed through the operating length of the mercury columns within the glass tubes. Two transmitters are used; two radio frequencies and two antennas are required. It is probable that constant tracking of the signals at the ground station is required to operate this set.

The Germans also use chronometric radiosondes that employ bimetallic elements to measure temperature and hair hygrometers to measure humidity. Temperature contacts are made twice a minute, humidity contacts once a minute.

The Japanese use radiosondes very similar to the German. Pressure is determined in much the same way as in the chronometric instrument of the Germans; however, there are only seven contacts. The Jap radiosondes have the same defect as the German, that they must operate on two radio frequencies, requiring two transmitters, two antennas, and constant tracking at the ground station.

The American radiosonde operates with one transmitter. The carrier frequency is audio modulated and variation in audio modulation can be translated into meteorological data. The received signal is recorded on a chart. The number of contacts can be counted and the conditions read. Some American radiosondes have 80 contacts; others 95.

All three countries use a battery for their radiosonde power supply. The foreign instruments use vibrators and transformers to obtain desired voltages and alternating currents. American instruments use batteries with the correct plate voltage and tap only certain components of the battery for the correct filament voltages.

[Editor's Note. — For pictorial description of U.S. radiosonde, see Page 220—MFB.]

Test Console Speeds Production of Dynamotors

CHICAGO. — With dynamotors undergoing extremely hard wear in war applications, which far exceeds the peacetime rigors, engineers of the Carter Motor Co., Chicago, have developed (for their own use only) a new type test console which puts all units they produce under actual operating conditions.

The tester consists of a wide-range instrument panel, a marine receiver, twin oscilloscopes and a set of storage batteries together with suitable outlets for 115-volts a.c. and d.c.

Not only can the input voltages be adjusted to approximate service conditions, but an overload may be placed on the outputs to establish the correct functioning of the dynamotors. Instruments indicate all voltages and currents simultaneously as well as commutator ripple. The battery voltages are controlled by suitable tap switches of high capacity together with high current rheostats.

Ripple in the input and output of any unit is read both on the indicator and on the twin oscilloscopes which visually show the condition of the commutator segments and the contact made by the brushes.

The receiver is used to check, by audible means and by a db meter, the hash, if any, which might affect the reception of signals at predetermined points in the r-f. spectrum. Thus each unit to come off the line is not only subjected to a performance check from the input and output angle, but also from the view point of how the unit will affect receivers in the location in which it is to be used.

A comprehensive and rapid technique has been established by which a com-

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plete and detailed diagnosis can be made of each dynamotor. It must pass all tests simultaneously to be approved by the test engineer.

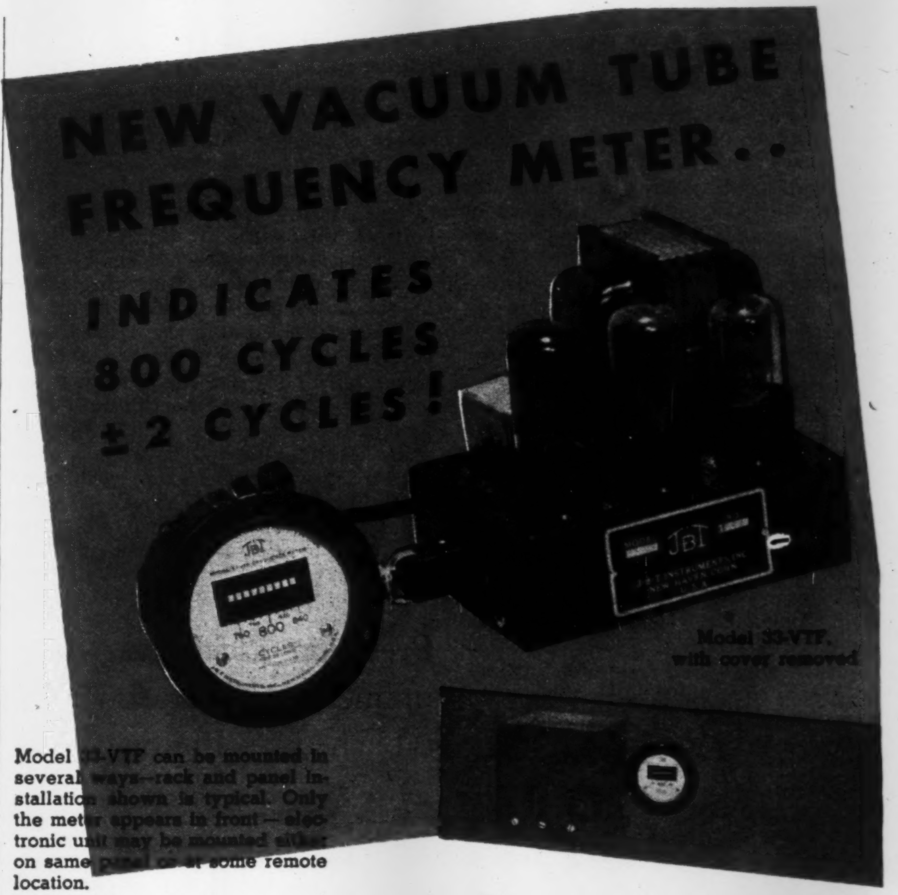
The interpretation of the various oscilloscope patterns by which the performance is determined is a matter of over two years' experimentation by Carter Motor Co. engineers. The use of the twin unit makes it possible to test multi-output dynamotors at input and output without disconnecting either secondary or primary and assures visual check of both outputs at the same time.

Outwitting the Nazis by Producing "Secret" V-t Amplifiers

WASHINGTON.—How quick thinking by the U. S. Army Signal Corps and quick production by U. S. industry outwitted the Nazis on at least one occasion in France has been disclosed by the Office of the Chief Signal Officer.

When the Germans withdrew from France they left almost intact the auxiliary telephone equipment which had been installed to supplement existing civilian systems. But they took pains to remove or smash the vacuum tubes which are essential to the telephone repeaters, tubes needed to overcome the weakening of the voice currents as they pass over miles of wire. The German intention was obvious. They believed that we could not replace these tubes, which were of a German type different from ours, and that we could not use their equipment.

One of these German tubes fell into the hands of Brigadier General Carroll O. Bickelhaupt, on duty with the Signal Corps in the European Theatre of Operations. He gave it to Dr. Vannevar Bush, Chairman of the National Defense Research Committee, who was about to return to the United States. Dr. Bush, upon reaching the States, had NDRC place contracts with two different American firms for copies of the sample. Each firm was to make a thousand of the tubes. One was to make approximate copies very quickly out of parts and materials already on hand; the other was to take the necessary time to make exact replicas, duplicating all the separate metal and glass parts that were in the German tube. The firm which was to rush through the approximations actually constructed the first eight tubes within three days; and within three weeks the entire lot had been delivered. To make such speed possible the tube-bases were manufactured by a friendly competitor, using an available mold hastily modified to meet the requirements. The firm which was to make exact replicas achieved this feat, which called for great technical care, in five weeks. These perfect copies, as fast as they were produced, were shipped to Signal Corps repre-


NEW VACUUM TUBE FREQUENCY METER..
INDICATES 800 CYCLES ± 2 CYCLES!
J-B-T
800
Model 33-VTF, with cover removed

Model 33-VTF can be mounted in several ways—rack and panel installation shown is typical. Only the meter appears in front—electronic unit may be mounted either on same panel or at some remote location.

MODEL 33-VTF, now released for commercial use, makes available the ruggedness and exceptional accuracy of the vibrating reed frequency meter. It measures specific bands such as 760-840 cps or 1140-1260 cps.

Again, J-B-T engineers have extended the useful range of the vibrating reed frequency meter—through use of a simple, practical electronic circuit. A vacuum tube multivibrator divides the incoming frequency by the proper integer, and shows the result on the widely used standard 400 cycle meter.

Harmonics of accidental frequencies or unusual wave form do not affect the response where the speed of the inverter or other frequency source is in the approximate range being measured.

Model 39-VTF, Laboratory Type, not shown, has an input impedance of 500,000 ohms, and uses regular line current for power supply. This model, through use of a multiplier switch, measures frequencies 1, 2, 3, 4, 6 and 9 times the basic range of 380-420 cycles.

Check These Features:

EXTREME ACCURACY... within 0.25% of frequency measured.

PERMANENT ACCURACY... calibrated at factory – no subsequent calibration or standardization required at any time.

STABILITY... no temperature drift after initial 30 second warm-up period. Accuracy is independent of line voltage variation. No voltage regulator, external or internal, is required.

BURN-OUT PROOF... no protection needed against accidental frequencies above the range being measured.

SIMPLE – LIGHTWEIGHT – COMPACT... only 3 tubes–6N7 multivibrator, 6V6 amplifier, 6X5 rectifier. Weighs only 6 lbs.... electronic unit 5½" x 6" x 4⅝"; meter meets JAN-I-6 mounting dimensions for 3½" instruments.

20 WATT POWER CONSUMPTION... derived from frequency source being measured.

J-B-T

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J-B-T INSTRUMENTS, INC.
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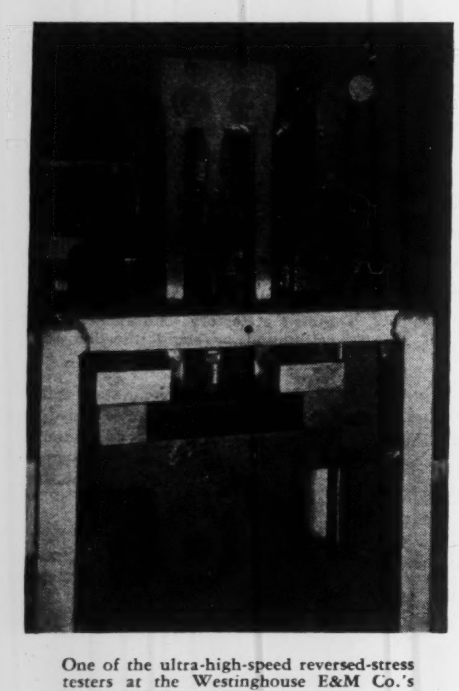
sentatives in France. They worked as well as the originals could have worked, and the telephone system functioned efficiently.

The original German tube was a cathode-type pentode, different from any known American tube, not only in electrical characteristics and in heater voltage but also in the dimensions of the bulb and in the disposition of the contact pins. In accordance with common practice in Europe it was provided with electrostatic shielding by means of a metal coating sprayed on it in the form of molten particles.

Ten Million Stresses per Day

PITTSBURGH.—Impatient with endurance test methods that require six years, engineers at the Research Laboratories of the Westinghouse Elec. & Mfg. Co. have devised high-speed test machines to check the new high-temperature alloys used in steam turbines, jet propulsion units, and other high-temperature machines. At room temperature, the story of endurance of a metal is usually told in ten million cycles of stress. But, at elevated temperatures, the curve of waning endurance continues downward for several hundred million cycles.



One of the ultra-high-speed reversed-stress testers at the Westinghouse E&M Co.'s Research Laboratories.

By ordinary means it takes years to stress an alloy sample held at, say, 1500°F. a quarter of a billion times. The special machines can do this testing job in a month. The test piece is clamped in a furnace that maintains the desired temperature. Through the clamping structure a stress is applied 120 times per second by two stator coils connected to a two-phase 60-cycle supply line. The entire system is mechanically tuned to resonance at this frequency to minimize the requisite driving force. This tuning also serves another highly desirable purpose. Research engineers want to see the specimen after the first tiny crack occurs, not after the complete failure of the sample. With this device, the first crack reduces the stiffness of the system, which detunes the mechanism to such an extent that the machine automatically stops. Thus a sample can be placed in the tester, heated to the desired temperature and the test started and allowed to run day and night without attention for weeks or months until failure just begins, after which the test stops itself without continuing until important evidence of the mechanism of failure is destroyed. Tests of high-temperature alloys up to a billion applications of stress have been made in 100 days.

Precision Electrical Measurements Laboratory Established at Illinois Tech.

CHICAGO — Dr. Henry T. Heald, president of Illinois Institute of Technology, today announced an initial grant of $15,000 from the Ohmite Mfg. Co. to be used for the establishment of a laboratory for precision electrical and magnetic measurements. The gift came through David T. Siegel, president of Ohmite and a trustee of Illinois Tech. It represents the initial contribution for equipping what will be known as the Ohmite Laboratory for Precision Measurements. It will be constantly expanded as new equipment becomes available.

The laboratory's ultimate goal is to provide precision electrical measurements for the Chicago area approaching in accuracy those of the National Bureau of Standards in Washington. Working through the Armour Research Foundation, industries in the vicinity will have an opportunity to use the laboratory's facilities. This will be the first such laboratory in the Chicago area to make its services available to industry. Its establishment augments the scientific and research facilities of the area. As an important addition to Illinois Tech's electrical engineering equipment it will enable graduate students to be trained in precision electrical measurements. It will further provide standards for research work carried on at the Armour Research Foundation of Illinois Tech, where it will be located.

The laboratory will be developed under Prof. E. H. Schulz, supervisor of electrical engineering laboratories, and L. W. Matsch, supervisor of electrical engineering in the Foundation. Also on the committee supervising its construction are Dr. H. A. Leedy, Dr. W. A. Lewis, Dr. Thomas C. Poulter, Raymond E. Zenner and Dr. James S. Thompson. It is hoped that the basic elements will be operating within six months, although some of the needed equipment cannot be obtained until after the war.

Mr. Siegel, in presenting the gift, stated the purpose of the laboratory as follows:

(1) To provide facilities for studying the fundamental measurement of resistance, inductance, capacitance, current, voltage, power, power factor, permeability, etc.

(2) To provide calibration facilities for instruments and meters used in research and industry by affiliated organizations at Technology Center and by industries of the Chicago area.

(3) To stimulate advanced training of the electrical engineering students at the Illinois Institute of Technology in the important field of precision measurements.

Power companies, manufacturers of various kinds of electrical equipment, and colleges are among the organizations which will immediately benefit from the project.

Instrumentation for Curing Rubber by U-h-f. Heat

AKRON, Ohio.—Part of the equipment for the vulcanization of rubber and other plastic materials by the oscillations of high-frequency electric waves which shake the molecules of the material and the vulcanizing agent millions of times a second, creating uniform heat throughout, is shown in the plant of The B. F. Goodrich Company, Akron, Ohio.

Modern ultra-high-frequency heating requires precise automatic control of several factors by means of instruments.

Charles W. Leguillon (left), manager

f the machine and process development ivision, and William Jenkins, elec onics engineer of B. F. Goodrich are own operating the new type vulcan ng apparatus.

For more than a century, vulcaniza on of rubber and other materials has en effected by applying heat to out de surfaces. Since rubber and other aterials which can be vulcanized in late against, rather than conduct at, this has been in most cases a slow ocess. In high-frequency vulcaniza on, uniform heat is created through t the material in a fraction of the me required by the older method. ponge rubber mattresses and pads ave been cured by the new process in e-eighth the time taken by the con entional method.

The same uniform heating so valu ble in vulcanization removes difficul es in the molding of thick plastic roducts. High-frequency heating also akes possible the use of simplified quipment.

Substitutes in Signal Equipment

WASHINGTON.—The U. S. Army ignal Corps has made substantial con ributions in devising substitutes for trategic materials needed for signal quipment. This program has included asic research in developing new alloys, eramics and glass and the work of esting scores of substitute materials n practical application. The method as evolved many successful substitutes hich have saved vast amounts of critical material. A few of the substitutes hich have been developed or sponsored by the Signal Corps are:

(1) Low-grade mica for low-voltage capacitor applications.

(2) Plastic materials for flashlights and signal lamps and special light projectors.

(3) Plastic insulation for wires.

(4) Magnesium instead of steel or aluminum or wood in radio chassis, antenna masts and antenna mounts.

(5) Plasticized ceramics developed as a substitute for mica in the manufacture of capacitors.

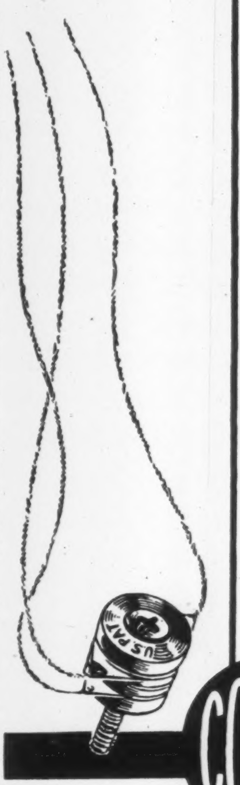
(6) Plasticized laminated paper and wood fiber in place of plywood.

(7) Insulators made of glass instead of certain critically short ceramics.

(8) Vibration absorbers, or shock mounts, made of substitutes for rubber.

(9) Meteorological balloons made of substitutes for rubber.

The above list of "ersatz" achievements by the Signal Corps could be multiplied manyfold. The urgencies of war forced this program, since numerous strategic materials were dangerously short in the early months after America's involvement in the world conflict.



Another

Conant

first!

A New Rectifier Assembly that Eliminates Temperature Variations

Here's important news for users of rectifier type instruments. Conant has done it again! This new instrument rectifier application makes possible for the first time complete freedom from temperature errors. AC values are read on the same linear scale as DC values.

You'll be amazed at the vastly improved frequency response achieved by this new development. This remarkable assembly can be furnished in any of three Conant series (500, 160 or 160-C).

Available to original purchasers of Conant Instrument Rectifiers *license free*. Write today for details.

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Export Div., 89 Broad St., N. Y. 4, N. Y.
50 Yarmouth Rd., Toronto, Canada

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department. Or write to Information Section, Instruments Publishing Company.

Radiation-pyrometer Receiver

New model of "Radiamatic" compensated radiation-pyrometer receiver embodies five major improvements making it secure against air and gases up to 1 lb./in.^{2} gage pressure at ambient temperatures up to 250°F. Improvements are: (1) Use of an adhesive sealing compound between lens and mounting rings; (2) use of brass for lens retaining and mounting rings; (3) controlled torque applied when assembling lens retaining and mounting rings; (4) two spanner wrench holes in lens mounting ring face replaced with a milled slot which avoids cutting through ring face; (5) use of a more positive sealing, with an improved adhesive, of sighting glass located in rear of thermopile assembly. Other improvements include use of aluminum instead of cast iron for "Radiamatic" housing.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

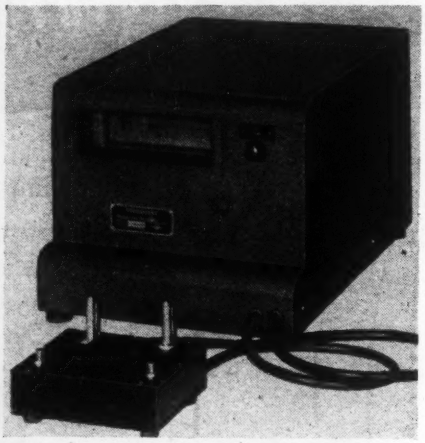
Combination Voltmeter, Power-level Meter and Output Meter

New "Model 695 Type 11," described as an extremely compact portable test instrument, is essentially a rectifier type voltmeter which provides readings in decibels as well as in volts, making it suitable for power-level measurements in sound equipment and in radio receivers as well as for a-c. voltage measurements from 2 to 200 volts full-scale. A medium speed instrument with moderately damped movement, "Model 695" has a constant impedance of 20,000 ohms. When connected across any sound line, ranges can be shifted continually without varying line impedance. Eleven db ranges are provided, from −4 to +36 db at zero on the db scale. This provides a total spread at 55 db (scale: −10/0+5). Seven a-c. ranges from 2 to 200 volts also are available. A self-contained capacitor, available through a separate pinjack, is provided for blocking any d-c. component. Instrument is calibrated for 500-ohm lines with a zero level of 6 milliwatts or 1.732 volts. Each instrument is supplied with a chart giving interpolation values on lines other than 500 ohms (from 5 to 10,000 ohms at 6 milliwatts zero level). Test leads supplied. Dimensions are approx. 5½" × 3¾" × 3⅛".—*Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*

SERIES COND.
VM
DECIBELS
VOLTS
WESTON

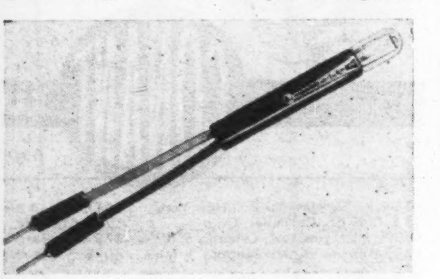
Insulation Resistance Tester

New "Vibrotest Model 238" insulation resistance tester is said to cover ranges heretofore thought to be impossible with this type. Indicating instrument is a spotlight galvanometer with 100-millimeter scale, calibrated 20,000 megohms, direct-reading where potential of 500 volts can be used. Power is obtained from self-contained battery supply with vibrator system providing 500 volts d.c. Complete guard circuit is provided for high ranges. Fixture at front is connected by insulated leads. Dimensions 16" × 11" × 9". Weight 24½ lbs.—*Associated Research, Inc., 231 South Green St., Chicago 7, Illinois.*



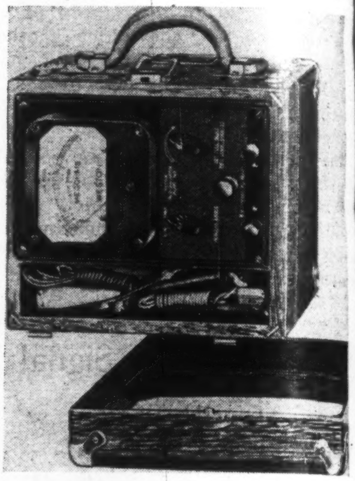
Low-voltage Circuit Tester

New "Lo-Volt Test Glo" is intended for testing circuits from 5 to 50 volts. It simplifies testing of open circuits, burned-out fuses, and can be used for indicating relative value of line voltage. Incandescent "glow" lamp is protected by a transparent plastic housing. Overall length is 7". Fully insulated test leads are 4" long. New tester is said to be particularly suitable for telephone repair men, automotive and aircraft mechanics and electricians.—*Ideal Commutator Dresser Company, 1060 Park Avenue, Sycamore, Illinois.*



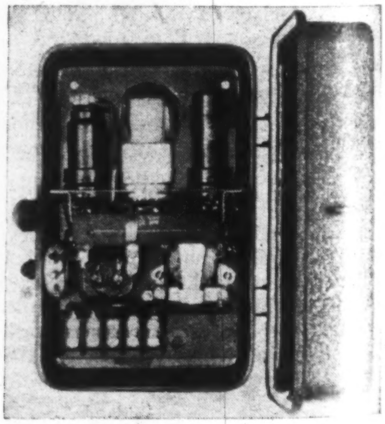
Direct-reading Insulation Tester

New "Model 796" direct-reading insulation tester, provides complete insulation and resistance tests up to 200 megohms at a d-c test potential of 350 to 500 volts. New convenience and unusual time-saving facility are claimed for this instrument. Leakage tests can readily be made in cramped quarters, operator always having complete freedom of both hands as when using any other direct-reading electrical instrument. Although test potential is 500 volts at terminals, current is only a few microamperes, thus making it impossible for operator under normal conditions to receive any harmful shock. New insulation tester operates from self-contained long-life light-weight batteries; has no vibrators or tubes to replace. It also can be used for general resistance measurements from 10,000 ohms to 200 megohms. Overall size is 8" × 8⅜" × 9"; weight is 15 lbs.—*Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*



Foundry-type Photoelectric Control

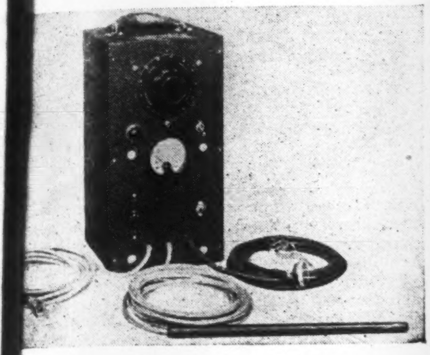
New "Photoelectric Control Type A20C" provides semi-automatic control of pouring operations in foundries. It is designed to replace pouring of molds by means of a manually-operated buggy ladle handled by an operator subjected to intense heat and occasional burns. With its help, one operator, working from a remote station, can control pouring of several ladles simultaneously. Several molds can be poured in



time than was needed to pour one the manual method. Each empty mold ves into position before a ladle, above ich a photoelectric unit is mounted. When lds are in place, operator, through push-ton control of hydraulic actuating mech-ism, tilts ladles and molten iron flows into lds. As metal reaches riser of each mold, brilliant light actuates photoelectric con-ller, which instantly drops ladle back, that pouring stops. Thus, although start- is not automatized, stopping is fully tomatized. New "Control Type A20C" erates from 115-volt 60-cycle a-c. supply d incorporates s-p. d-t. relay for normally-en or normally-closed operation. Relay ntacts are designed to handle 10 amperes c. or 5 amperes d-c.—*Photoswitch Inc., Broadway, Cambridge 42, Mass.*

Insulation Resistance Tester

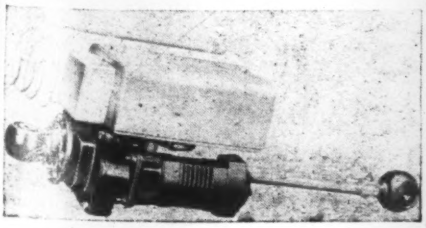
New insulation tester that can be carried one hand and plugged into any 115-volt -cycle outlet, is capable of supplying test ltages from 0 to 2500 volts, has a capacity 750 volt-amperes and will stand one-inute loads of 1500 va. without injury. It



an be used to test electric apparatus ranging from the wiring for small appliances to Diesel-electric locomotives up to 600-hp. Set consists of a dry-type step-up transformer, variable autotransformer for smooth voltage control, indicating voltmeter, air circuit breaker with instantaneous overload trip, and control switches. Two 15-ft. shielded test cables (one with an insulated test handle and the other with a spring clip for grounding one side of the high-voltage circuit) and a 15-ft. supply cord with a connecting plug and ground clip, are also provided. Entire unit weighs 47 lbs. including the crackle-black enameled case measuring 15"×7¾"×8¾". This set is said to give highly accurate indication of test voltage because voltmeter is supplied from a separate coil on transformer winding and is arranged to give full-scale readings at either 2500 or 1250 volts. New set has several safety features such as third conductor in supply cord which grounds the steel case, a red signal lamp which remains lighted while set is energized, and shielded and grounded high-voltage test leads.—*General Electric Co., Schenectady 5, N. Y.*

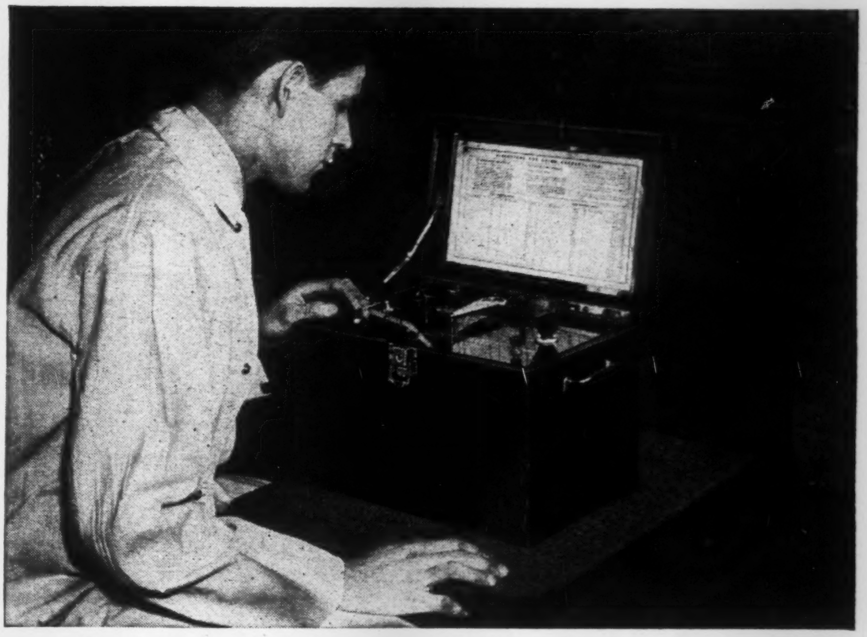
Electromechanical Actuators

New "Model 400" series of linear actuators, weighing as little as 3.05 lbs., have been built specifically to meet aviation industry's demand for an efficient method of converting electrical energy into linear actuating force, with least possible weight and

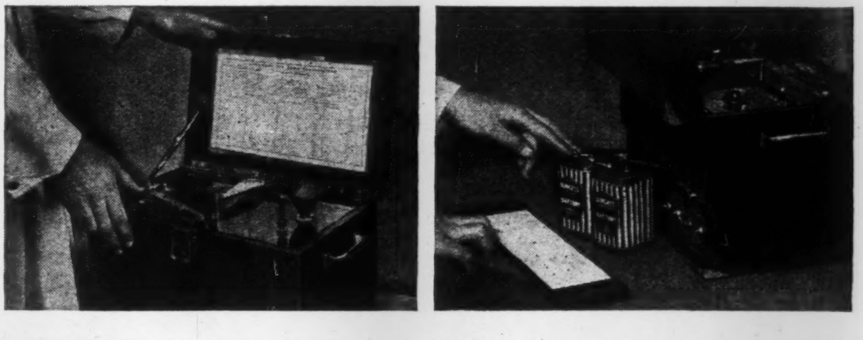


PORTABLE POWER PROBLEMS

THIS MONTH—FISHER CARBANALYZER



TIME-SAVING carbon content analyses of steel samples—from molten metal to report—take only five minutes with the portable, *battery-powered* Carbanalyzer, produced by the Fisher Scientific Company. Leading steel firms employing open hearth or electric furnaces quickly make carbon determinations of each steel batch, achieving close control of quality.



CARBANALYZER, powered by Burgess Industrial Batteries, operates over a range of .05% to 1.50% carbon content and is sensitive to a change of ± .005%. The power requirements of modern control and test instruments are fully met by Burgess Industrial Batteries—the standard of quality for all commercial uses. The types you require may not be immediately available today since industrial battery production is greatly reduced by urgent war needs.

Burgess Battery Company, Freeport, Illinois

No 2
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SUPER SERVICE
UNI-CEL
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COMPANY

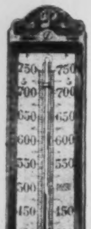
BURGESS BATTERIES

ARMY E NAVY

FOOD IS A WAR WEAPON—USE IT WISELY!

Famous for the WORLD'S MOST COMPLETE LINE of dry batteries

Heroes
AT WORK
U.S. ARMY



For MOM . . . it's INSPECTION
For HER son . . . it's FIGHTING

And together they do a grand job. For Mom is on the job, every day, inspecting each thermometer before it can be shipped and nothing gets by her eagle eye. It's folks like this, who are imbued with a spirit of loyalty to our firm who are responsible for the fine Thermometers that help you to make a finer product.

Remember, in post-war plans, only GOOD Thermometers should be considered in rebuilding your future sales.

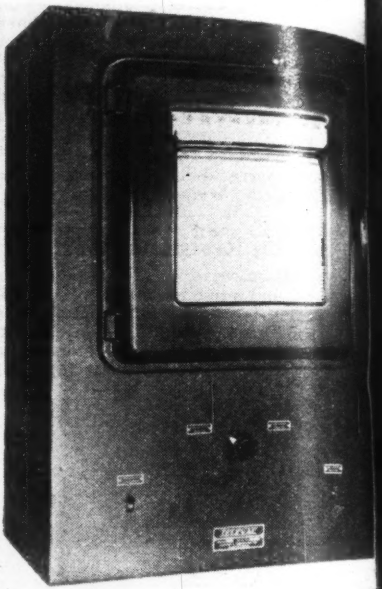
Clip this ad as a reminder (Catalog on request)

THE PALMER COMPANY
Mfrs. of Industrial Recording and Laboratory Thermometers
2525 NORWOOD AVENUE CINCINNATI 12, (Norwood) OHIO
Canadian Plant: King and George Sts., Toronto

size of electromechanical units giving required strength and power. New "Model 400" actuators are designed to operate under loads up to 400 lbs. of compression or tension. They operate on 24-28 volt circuits and are said to have extremely low current drain on the electrical system. New model is less than 5" wide and less than 7" long including limit switch control box and thermal protector. Extension length ranges from 14⅞" to almost 25". New actuators provide a complete package inasmuch as unit takes electricity and provides desired moving force without need of additional accessories. Exact positioning under all conditions is an outstanding advantage claimed. Control boxes are equipped with limit switch control of two or three or more positions. Incorporation of maker's "Fastop" clutch eliminates any over-travel. A movement of a few thousandths of an inch disengages driven disk of clutch from driving disk which is secured to armature shaft. Gear reduction ratios are available in various combinations. Position-indicating transmitters for visual check are also available. Lear motor runs at average speeds of 9 to 11,000 r.p.m. and is designed only for intermittent duty. Special design can be furnished for continuous duty. Lear controls which respond automatically to changes in temperature are available. Immersion elements for use with air, oil or glycol, as well as manual controls, can be supplied. Illustration shows "Model 400E" with temperature control. Weight, 4.22 lbs.; operating force, 300 lbs.; static, 1500 lbs. Aircraft applications for new "400" series include air filter doors, intercooler shutters, carburetor air duct shutters, trim tabs, dive flaps, oil cooler shutters, and glycol cooler shutters.—*Lear Avia, Inc., Piqua, Ohio.*

Two-range Vacuum Recorder

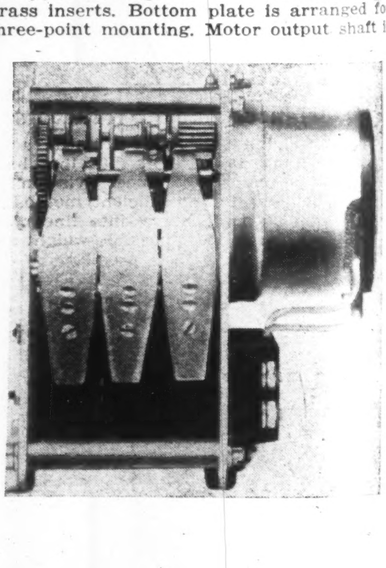
New "Type S' recorder, added to "Televac" line of vacuum instrumentation, has been designed for high-vacuum processes such as electron-tube manufacture, etc.



where pressures are less than 1 micron. It provides two ranges, depending on which primary element is utilized: (1) with "No. 500 Thermal Gage," range is 0-500 microns; (2) with "Type 31" ionization gage or other primary element of equivalent characteristic curve, range is 0-0.4 micron. Accurate readings with "Type 31" ionization element are obtained down to 0.001 micron. New "Type S" instrument also features a safety circuit which makes it impossible to turn on the ionization gage until a vacuum of 1 micron has been reached. Average life of ionization gage is 3000 hours.—*Precision Scientific Co., 1750 N. Springfield Ave., Chicago 47, Illinois.*

Time Delay Relay

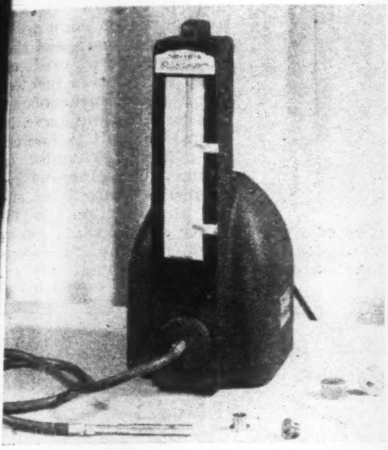
New "Type MCR" motor-operated time-delay relay was developed particularly for airborne radio equipment but can be used in industrial applications where only d-c. power is available or in a-c. applications where its small size and weight make it more suitable than standard equipment. Overall dimensions, $2\frac{9}{16}$" wide, $3\frac{13}{16}$" long, $3\frac{3}{16}$" high. Weight without cover, approx. 1 lb. Maximum time ranges, 25 sec., 50 sec., 2½ min., 5 min., 10 min. (minimum time settings from 1¼ sec. to 30 sec. respectively) Mounting frame is duralumin with brass inserts. Bottom plate is arranged for three-point mounting. Motor output shaft is



nnected to cam-driving mechanism by uni-
rsal joint and magnetically-operated gear
tch. On camshaft, a pair of cams rotate
th main shaft to actuate switches; a re-
rn spring resets cams to starting position
hen timer is de-energized. Switch units
e fully enclosed s-p. d-t. with quick double-
ake double-break contacts rated at 10
nps. on either 24-volt d.c. or 110-volt a.c.
a level to 40,000 ft. One switch unit pro-
des independent load circuit; the second
used for motor control. (A third switch
r a second load circuit can be provided as
ecial).—*The R. W. Cramer Co., Inc., Cen-*
rbrook, Conn.

Redesigned Pneumatic Gage

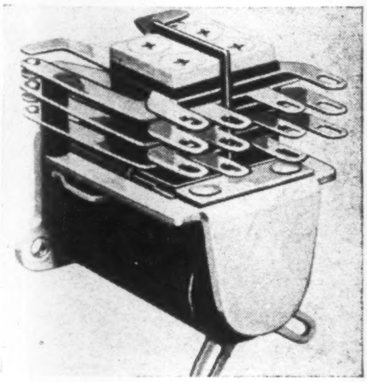
New high-amplification "Precisionaire"
rovides an amplification of 20,000 to 25,000
1 (a spread of 2" to 2½" per 0.0001") on
ternal measuring and is graduated in five-
illionths of an inch increments. Action of
e floating indicator is just as quick and



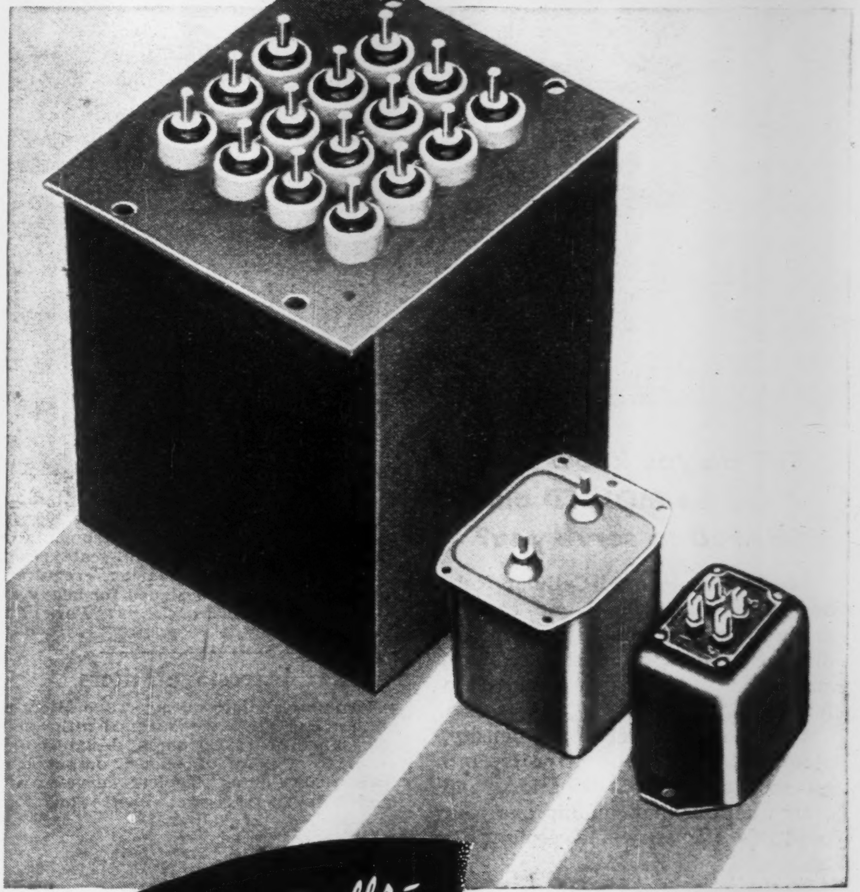
stable as in lower-magnification models which have been in use by industry for several years. The base instrument has the same general appearance, but has been modified with specially built high precision metering components. Master gaging rings and spindles are said to be made to an extraordinary degree of accuracy.—*Sheffield Corp., Dayton 1, Ohio.*

Signal and Communication Relay

"R-B-M Type 23000" signal and communication relay for aircraft service weighs 1¾ oz., is said to be equally adaptable for non-aircraft applications requiring exceptional resistance to vibration, humidity and temperature extremes. Specifications include 6 normally open contacts; contact rating, 3 amps, d.c. non-inductive. Also available in other arrangements of normally-open and normally-closed contacts. Vibration resistance up to 10 *g* at 40,000 feet; temperature ranges, −65°C. to +85°C.; approx. dimensions, 2$\frac{1}{16}$" long, 1½" high, ¾" wide. Design and construction meet Signal Corps requirements for resistance to humidity, salt



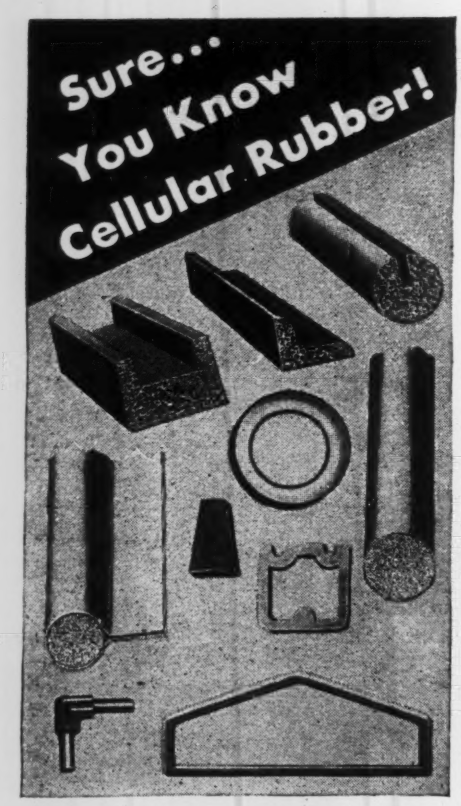
STANCOR
Precision-Built TRANSFORMERS



Breathing Spells-

We do have a little time—now and then only—to discuss transformer applications with our fellow "victory manufacturers" who are seeking to improve their war-time units and—also those whose plans include design for the future . . . Possibly time may be found for *you*. We'll do our best with your inquiry.

STANDARD TRANSFORMER CORPORATION
1500 NORTH HALSTED STREET, CHICAGO 22, ILLINOIS



BUT do you know how it can be MOLDED and SHAPED to serve you?

Modern engineered Cellular Rubber is *available now*—and can be made to order—molded to shape, in die cut designs, or in sheets, slabs, strips, cord, tubing, or bonded to fabrics.

Our methods control its density, strength, resistance to oils and greases, chemicals, oxidation, and other qualities that can improve your product's efficiency and prolong its life.

Basic forms are: SPONGEX* with interconnecting cells—CELL-TITE* *soft* with individual cells. Also rubberized curled hair and bound fibre forms for cushoning or packing delicate instruments. *Why not send for samples and prices.*

**Trade Mark Reg. U. S. Pat. Off.*

Sponge Rubber Products Co.

236 Derby Place, Shelton, Conn.

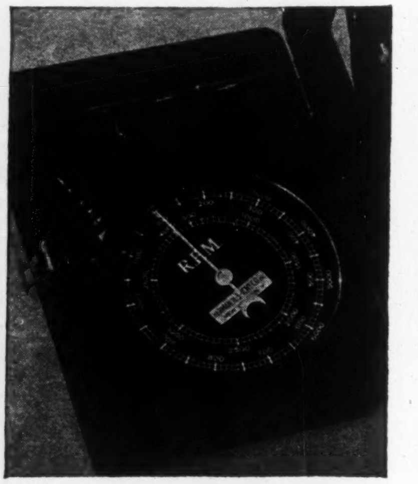
Plants in Derby and Shelton, Conn.
Sales Offices: New York • Chicago
Washington • Detroit.

WORLD'S LARGEST MANUFACTURERS OF CELLULAR RUBBER AND BONDED FIBRE PRODUCTS

spray, and fungus. Magnet coil bobbin is of high-impact specially-molded phenolic material of high insulating value, resistant to electrolysis and capable of withstanding severe humidity. Entire contact pile-up assembly is baked 100 hours at 230°F. After baking operation, all screws are re-tightened, contacts aligned and pointed. This type of relay also available with heavy-duty contacts rated at 10 amps, 28 volts d.c. non-inductive. — *R-B-M Mfg. Co. Div., Essex Wire Corp., Logansport, Indiana.*

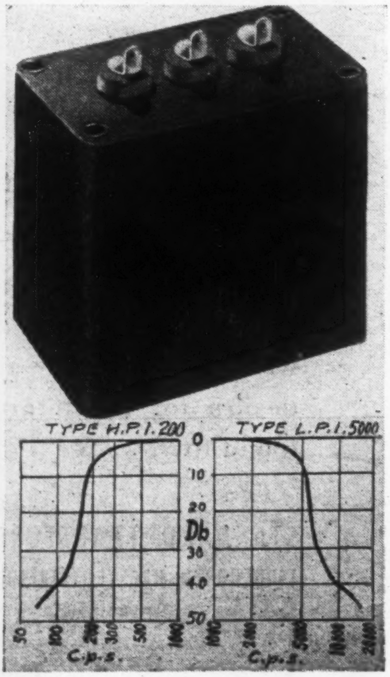
Hand Tachometers

Two new models have been added to maker's line of triple-range centrifugal-type hand tachometers: new "No. 1412" for all speeds from 100 r.p.m. to 12,000 r.p.m., and new "No. 315" for all speeds from 300 r.p.m. to 15,000 r.p.m. Both new instruments have an accuracy of 1% of full-scale reading, are completely ball-bearing, require no lubrication and are designed for heavy duty. —*Herman H. Sticht Co., 27 Park Place, New York 7, N. Y.*



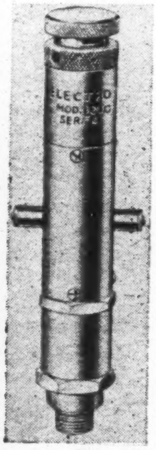
Interstage Filters

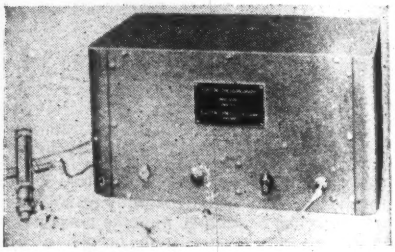
Two new audiofrequency-wave filters added to maker's line are designed with nominal impedance of 10,000 ohms, designed to operate from plate of triode, output loaded with 10,000 ohms. Typical curves are included in *Instruments'* illustration. Filters can be supplied for any cut-off frequency between 200 and 10,000 c.p.s. Units are 2½" high, employ dual alloy magnetic shield said to reduce inductive pick-up to 150 mv. per gauss.—*United Transformer Co., 150 Varick St., New York 13, N.*



Pressure Pick-up and Amplifier

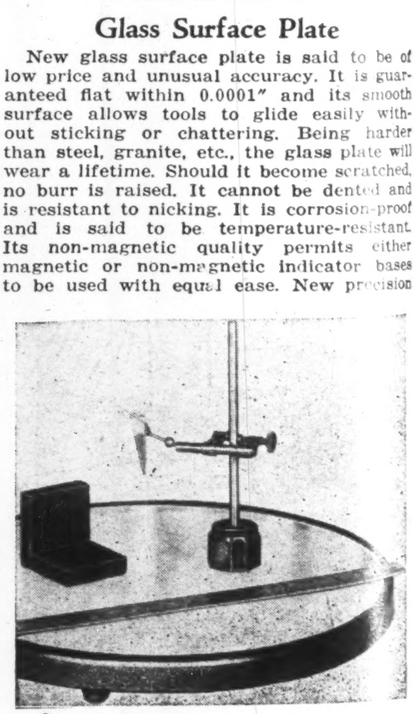
New "Pressuregraph" is described as a linear pressure-time-curve indicator. Manufacturer claims that it will indicate, in linear response on the screen of a cathode ray oscillograph, the pressure-time curve of engine, pump, airline, or other enclosed system where pressure measurements are desired. "Pressuregraph" measures either static or dynamic pressures. It is stated to have been successfully applied to 2-cycle engines to show pressure-time curve of main cylinder or crankcase and also to have been used on C. F. R. aviation fuel test engines for measurement of pressure-time curve. In operation, unit is inserted in cylinder, chamber or airline, etc. Pick-up response is transmitted, after amplification, to the screen of a cathode-ray oscillograph. Among advantages claimed for the "Pressuregraph" are simplified operation, only one control being required, with one initial adjustment to compensate for temperature effects.—*Electro Products Laboratories, Inc., 549 W. Randolph St., Chicago 6, Ill.*





Glass Surface Plate

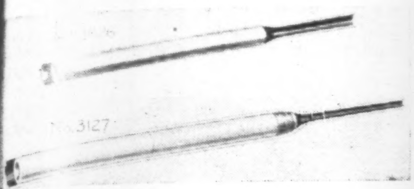
New glass surface plate is said to be of low price and unusual accuracy. It is guaranteed flat within 0.0001" and its smooth surface allows tools to glide easily without sticking or chattering. Being harder than steel, granite, etc., the glass plate will wear a lifetime. Should it become scratched, no burr is raised. It cannot be dented and is resistant to nicking. It is corrosion-proof and is said to be temperature-resistant. Its non-magnetic quality permits either magnetic or non-magnetic indicator bases to be used with equal ease. New precision



glass surface plate is a 16" diameter disk of heavy glass, housed in a metal standard. A protective felt cover is supplied with each plate. —*Main Electric Co., Inc., 1462 East Main St., Rochester, N. Y.*

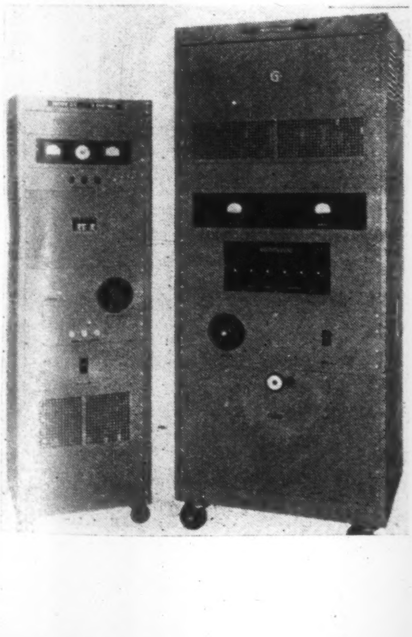
Combustion Tubes

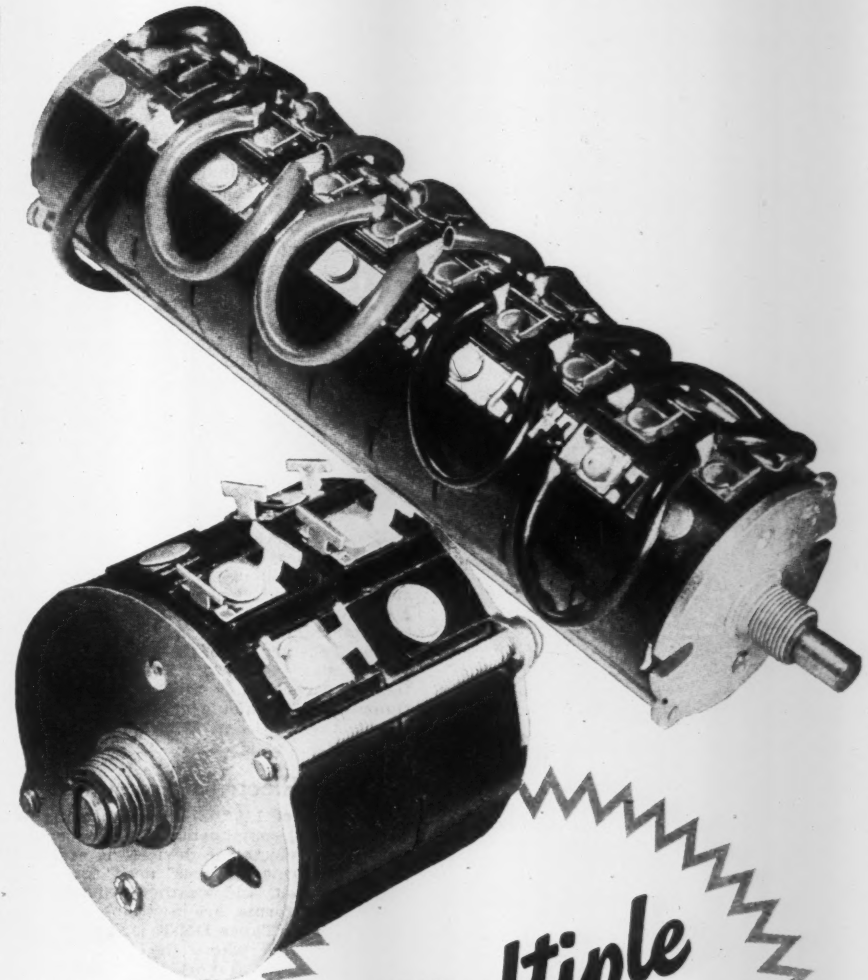
New combustion tube assembly for carbon and sulfur determination in metals and other combustible materials is announced. Two lengths of cylindrical refractory tube liners are inserted within the combustion tube. Assembly is inserted within a high-temperature laboratory combustion furnace. Boat containing weighed sample is placed within liner at center of combustion tube. This center liner will protect combustion tube from metal and slag splatter. When center liner becomes so full of splatter that it interferes with boat passage, it is removed and a new liner is inserted. Combustion tube life is increased when liners are used. New combustion tube assembly is said to make for time-saving and more economy than the practice of using boat covers.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.*



Tube-life Tester

New life-test unit for electronic tubes simulates actual electrical operating conditions. Equipment comprises two complementary units: plate supply rectifier, and life-test cabinet. Up to 1¼ amperes at potentials up to 2000 volts for plate supply to tubes under test are provided by plate rectifier. This unit is three-phase operated; it includes a filter, continuously-variable voltage control, time-delay relay, door-interlock safety switches, supervisory lamps, voltmeter, ammeter, interlock circuits for connection to the life-test cabinet, and running-time meter which registers test duration. Life-test cabinet accommodates six triodes under test with total plate dissipation of over 2kw. This unit incorporates continuously-variable filament supply, a filament voltmeter, regulated grid supply, plate ammeter, circuit breaker, supervisory lamps, door safety switches and interlock circuits associated with the plate supply rectifier. Interlock circuits which cut off plate supply if grid bias fails, or if access doors are opened, provide safety for operator and for tubes. Other features are means for independent control of grid bias





Multiple CONTROLS

Single shaft passes through and locks with rotor of each unit.

Each unit can be wound to precise circuit requirements, as to resistance, taper, tap, hop-off.

Interlocking resistance ratios provide any desired voltage or current at given degree of rotation.

Note dual unit with screw-driver adjustment. Such assemblies are serving in the most intricate electronic assemblies.

★ For three or more controls in tandem, Clarostat Type 42 is the logical choice. The bakelite cases of these rheostats or potentiometers nest and lock together for a virtually solid casing. Metal end plates and tie rods insure a rigid assembly—even up to 20 units in tandem. This unit is the solution to your multiple-circuit control. Back-lash is completely eliminated. And it is typical of that Clarostat "know-how" which provides the answers to all your resistor, control or resistance-device problems.

★ **Submit your problem!**

CLAROSTAT *Controls and Resistors*

CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

on each tube under test, and provision for independent plate current measurement of each tube under test. Since filament voltage, grid-bias voltage and the plate supply voltage are all variable, it is possible to adapt this new test unit for testing other types of tubes by changing the tube sockets.—*Green Electric Co., 130 Cedar St., New York 6, N. Y.*

Frequency and Time Meter

New "Model 31-FE" electrical indicating instrument combining frequency meter and elapsed time meter in one case saves both panel space and weight. Applications include engine-driven generator sets and other equipment where proper operating speeds, lubricating and overhaul schedules are important considerations. Frequency or speed is indicated to an accuracy of ±0.3% by a bank of 5 reeds calibrated in single-cycle steps from 58 to 62 cycles. Running time meter is driven by a synchronous motor, and indicates elapsed time in hours and tenths. Instrument operates on 110 volts, is also available for 48 to 52 cycles and in half-cycle steps for 59 to 61 cycles and 49 to 51 cycles, with accuracy of ±0.2% Other ranges are under development.—*J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.*

Jal
58 60 62
CYCLES PER SECOND
ELAPSED TIME

Hermetically-Sealed Electrical Instruments

New line of 2½" hermetically sealed panel instruments, housed in steel cases and immune from the effects of humidity, moisture, chemical fumes and other harmful agents, is announced. D-c. voltmeters and ammeters and a-c. radio-frequency ammeters, can be furnished in all standard ratings mentioned in, and conform to performance requirements of, American War Standard ASA Specification C-39.2-1944. They especially meet demand of Armed Services for moisture- and fungus-proof indicating instruments used under tropical climatic conditions. In obtaining a hermetically sealed enclosure, a thick strain-free glass window is sealed to a metal ring, obtaining a glass-to-metal seal, and this in turn is sealed to a case by a soft-soldered joint. Hermetic sealing of the two terminal studs is obtained by a glass-to-metal seal between each metal stud and metal eyelet. Entire hermetic assembly is sealed to steel base by a silver-solder operation. Metal base is secured to case by synthetic-rubber gasket coated with sealing compound. Seal is obtained by a crimped-over metal ring which compresses and retains gasket. Glass seal, soldered joints and metal ring form a completely hermetic enclosure for the instrument. This means of sealing is unaffected by thermal shock, mechanical shock, or fatigue vibration. Final assembly is evacuated, filled with an inert gas through a seal-off tube in base, and is sealed off at a pressure slightly above atmospheric. Made for flush mounting on nonmagnetic or steel panels, these instruments incorporate standard 2½" internal-pivot element in a steel case which shields them from stray magnetic fields. They are capable of withstanding a thermo-shock test of at least 10 alternate exposures in salt water at 85°C. and then at 0°C., without evidence of moisture penetration or damage to finish or enclosure.—*General Electric Co., Schenectady 5, N. Y.*

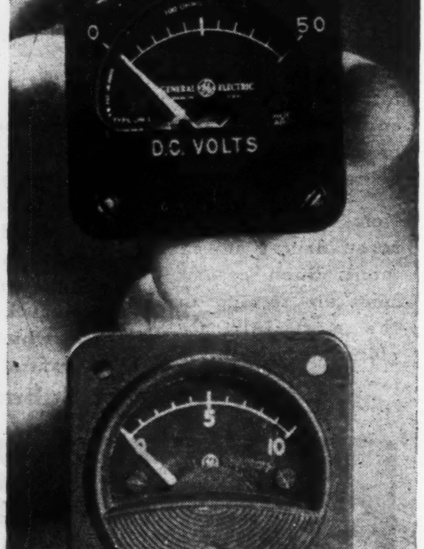
D-C VOLTS
5
10
15
MR25WO15DCVV
GENERAL ELECTRIC

Machine Speed Calculator

New vest-pocket plastic slide-rule instantly determines correct speed for all metal-cutting operations, enables machinists and supervisors to select most efficient cutting speeds for both high-speed and carbide machining operations. Readings from 10 to 1,000 feet per minute can be obtained. Handy size (6" long, 1" wide) permits on-the-spot check of actual machining conditions.—*Grove Calculator Co., 6644 Cottage Grove Ave., Chicago 37, Ill.*

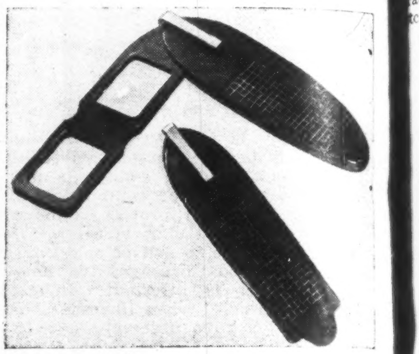
1½" Electrical Instruments

New line of 1½" electric indicating panel instruments, components of most communication and electronic devices, is announced. To meet Armed Forces' need for smaller, more compact, and weather-resisting equipment, two forms are available: a watertight design (Types DN-1, DN-2 and DN-3) for application where the equipment may be accidentally submerged in water, exposed to rain, or used in extremely humid climate; and a conventional design (Types DN-4, DN-5, and DN-6) for use in aircraft or for other service where instrument will be protected from the elements. Both series have same basic design in utilizing an internal-pivot element of permanent-magnet moving-coil class. In waterproofing test, Types DN-1, -2, and -3 resisted moisture and leakage when submerged in 30 feet of water for 24 hours. Both types will withstand vibration tests specified in American War Standard ASA Specification C-39.2-1944. They are available in nearly all ratings for d-c., r-f. and a-f. measurements, and are mostly for use with external thermocouples or rectifiers.—*General Electric Co., Schenectady 5, N. Y.*



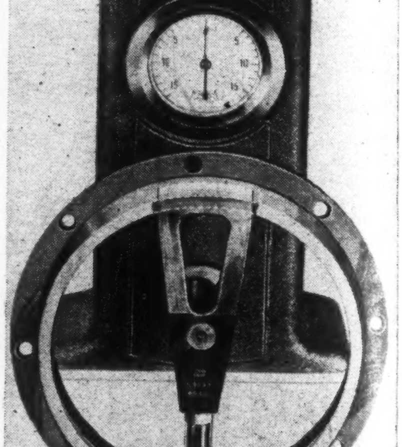
Binocular Magnifier

New "Twin Reader," said to be an innovation in hand magnifiers, is of the binocular type incorporating matched and balanced dual lenses of the "finest optical glass" mounted in a holder which folds back into plastic handle which has gold-plated pocket clip. Owing to its design, it can be held in a viewing position with either hand It is said to enable user to examine objects greatly magnified, with the clarity of normal third-dimensional vision or true depth perception with freedom from distortion and aberrations. It may be used in conjunction with corrective glasses. People with subnormal vision will find it an aid to better vision but it is not designed to take the place of corrective glasses. Manufacturer announces that initial production will be in focal lengths from 8" to 14" (from the eyes) and in three different magnifications. —*Edroy Products Co., 480 Lexington Ave., New York 17, N. Y.*



Internal-diameter Gage

New accessories for "Hole Checker" provide speedy method of gaging inside diameters of large parts to very close tolerances as shown by illustrated bearing-housing application. A special sizing plug was developed, with upper part of plug finished to exact radius of inside of bearing housing.



ower part carries gaging head, which is librated for high and low limits of accucy. Contact point is highly-polished wearsisting Nitride. Manufacturer claims that using this type sizing plug, work can checked easily for size, taper and out-ofund condition on large diameters. "Hole ecker" unit is air-operated and is set ith high and low limit master ring gages. olerance is 0.0005".—*The American Gauge o., 136 Bayard St., Dayton 1, Ohio.*

Engine-hour Meter

New electrically-operated engine hour eter registers hours, and accumulated umber of hours, of operation for trucks, actors, marine motors, engine-driven units, c. It is suitable also for use by laboratories or on testing work. Hours of operation are indicated by three hands: one turns one complete revolution in 100 hours; the second, one rev. in 1,000 hours; the third, one rev. in 10,000 hours. Easily mounted on instrument panel, the engine hour meter operates through ignition switch, or by use of a special pressure switch. Available in d.c. in ranges from 6 to 115 volts: in a.c. in 110-volt 60-cycle and 220-volt 60-cycle operation. It measures approximately 2⅞" × 2½".—*John W. Hobbs Corp., 2040 Yale Blvd., Springfield, Ill.*

0
1
2
3
4
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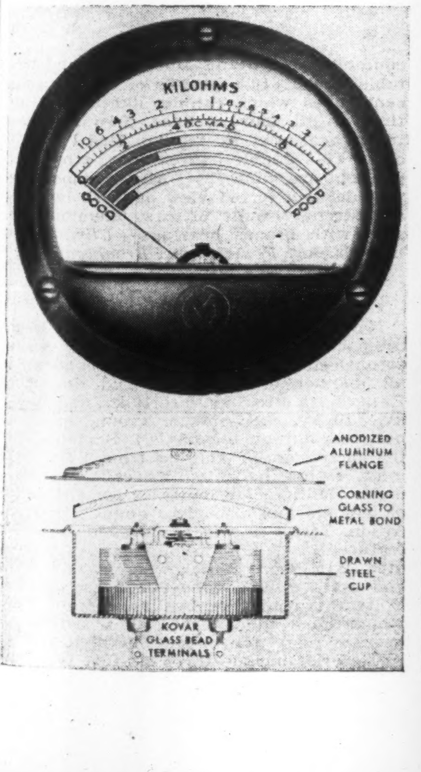
6
7
8
9
X10 HRS
(100HRS)
1000 HRS
ENGINE HOURS
HOBBS CORP. SPRINGFIELD, ILLINOIS

Hermetically-sealed Electrical Instruments

New hermetically-sealed 2½" and 3½" electrical indicating instruments utilize principles of vacuum-tube sealing, i.e., glass-to-metal, in addition to other design refinements. It is claimed that by building mechanism into a protective cup-like frame,



BETTER
PERMANENT MAGNETS
for:

RADIO, SOUND and COMMUNICATIONS EQUIPMENT

AUTOMOTIVE and AVIATION EQUIPMENT

INSTRUMENTS

ARMY E NAVY

However advanced your own product-development work may be . . . however new or revolutionary the permanent magnets you require . . . Arnold engineers can be of considerable assistance to you in supplying the proper permanent magnets *in volume.* They're precision-built entirely in our own plant, under the closest metallurgical, mechanical and magnetic control to assure peak efficiency at the lowest cost.

PERMANENT MAGNETS for Industry

NEW! Get your copy of this valuable, up-to-the-minute manual on the design, production and application of modern Alnico permanent magnets. Write us, on your company letterhead, today.

Specialists in the manufacture of
ALNICO PERMANENT MAGNETS

THE ARNOLD ENGINEERING COMPANY
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

AGASTAT
TYPE ND-21 NO. 60001
TIMING MIN. 5 SEC.
COIL MOM-24 V. DC CY.
PATENTED
ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR CO.

AGASTAT
ELECTRO-PNEUMATIC RELAY

COMPACT:
4 IN HIGH
2½ IN DEEP
2½ IN WIDE
WEIGHT:
1½ POUNDS

ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR COMPANY

Interval Timers

Process Timers

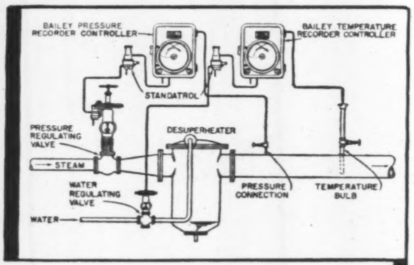
Signal Timers

Time Switches

Relays

Write

AUTOMATIC
ELECTRIC
MANUFACTURING CO.
MANKATO, MINNESOTA


BAILEY PRESSURE RECORDER CONTROLLER
BAILEY TEMPERATURE RECORDER CONTROLLER
STANDATROL
PRESSURE REGULATING VALVE
DESUPERHEATER
STEAM
WATER REGULATING VALVE
WATER
PRESSURE CONNECTION
TEMPERATURE BULB

DESUPERHEATING & PRESSURE REDUCING CONTROL

● Bailey Meter Control of desuperheating and pressure reducing incorporates standard Bailey Recorder-Controllers for both pressure and temperature, as well as a special Bailey Reducing Valve equipped with valve positioner and air cooled packing gland.

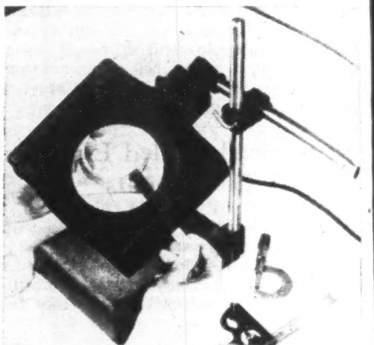
The control system is air-operated and is arranged to maintain the desired final steam temperature by controlling the quantity of water fed to a cartridge type desuperheater. This temperature is measured by a sensitive bare bulb temperature recorder-controller with the temperature bulb located at the ● outlet of the desuperheater.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

and then sealing glass cover to metal ri positive hermetic sealing has been effect with a minimum number of seals. The are no rubber gaskets or cement seals. Ne instruments can be immersed in boili brine solution for weeks, or frozen —40°F., without deterioration of seals. O was alternately boiled and frozen for 1 hour periods for eight days: maximum ze shift was 0.5% of scale range and "the was absolutely no moisture penetration Window sealing process was developed a perfected in coöperation with engineers Corning Glass Co. Windows are of doubl thickness shock-resistant tempered glas processed for solder sealing. Instrumen are completely dehydrated, then filled wi dry air at sea-level pressure. New design crowned crystal permits greater scale lengt reduces shadows and makes for better vis bility. Magnetic shielding makes possib interchangeability on any type of pan without affecting calibration. For extra r shielding, instrument can be supplied silve plated. Silver-clad beryllium-copper hai springs minimize zero shift at all temper atures. Other features are standard Kova glass bead type terminals with solder lugs and special phosphate finish on the ca which meets 200-hour salt spray test. Ne instruments are built to American Wa Standard specifications are available in a d-c. ranges. "Type HM 2" is directly inte changeable with A.W.S. type MR 24 an 25. "Type HM 3" is directly interchangeabl with A.W.S. type MR 34 and 35.—*Mario Electrical Instrument Co., Manchester, N. H*

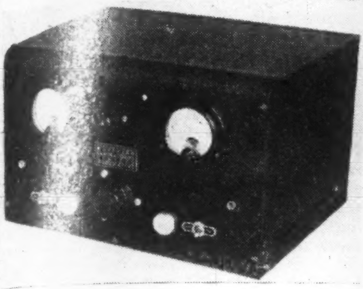
Illuminated Magnifiers

Newest additions to "C-Master" line o magnifiers are three all-angle illuminate models. Two of these are stand models; th third is a portable hand type. Lightin equipment of "Stand Model 410" and "Portable Model 610" consists of four incandescent tubes which can be lighted two at a time or all four at once. Two fluorescent tubes are used in "Stand Model 210." A clear 4½" double convex lens, ground and polished, magnifies 2×. All three magnifiers provide undistorted view of work inspected. are strongly built of cast aluminum and steel with bronze bearings.—*Ullman Products Co., 857 Fourth Ave., Brooklyn 32, N. Y.*



High-voltage Tester

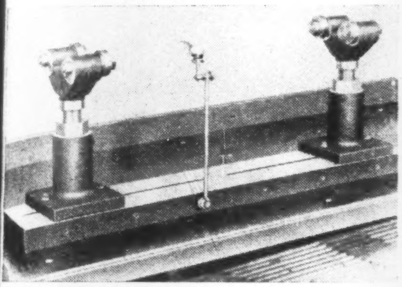
New "Model NL 5-H5" is a light-weight compact high-voltage supply for testing corona effects, leakage and breakdown of all manner of dielectrics and assemblies. Ranges are 0 to 5 kv, 0 to 10 kv. and 10-0-10 kv. (10 kv. each side of ground or 20 kv. between output terminals.) Supplies from the increment of voltage from 0 to maximum rating indicated by calibrated voltmeter. Milliameter indicates commencement of leakage and also gives quantitative indication. Tester is said to have unique safety features in that high-voltage relay is operated by a Micro-Switch when cover is lifted and extra ground connections are supplied. Voltage is controlled by Variac transformer which must be returned to 0 position to operate relay for cutting in high voltage. Accessories include three six-foot test leads



ith banana jacks and alligator clips. hese units are suitable for either laboraory or production testing. "Model NL5-H5" an be supplied with auxiliary capacitor netork for momentary high-current breakown tests. Normal current range is 0 to 1 milliamperes. Auxiliary capacitor netork furnished in separate steel box with arge porcelain standoff insulator for high oltage terminal and known as "Model NL5-5-IU."—*Northern Laboratories Ltd., 3-01 wenty-seventh Ave., Long Island City 2, ew York, N. Y,*

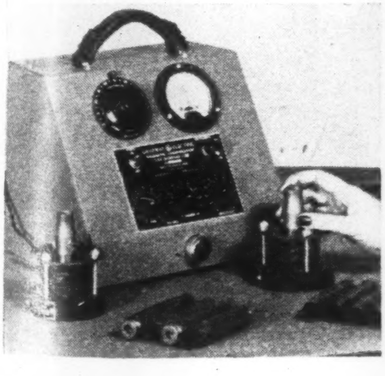
Aircraft Engine Crankshaft Aligning Fixture

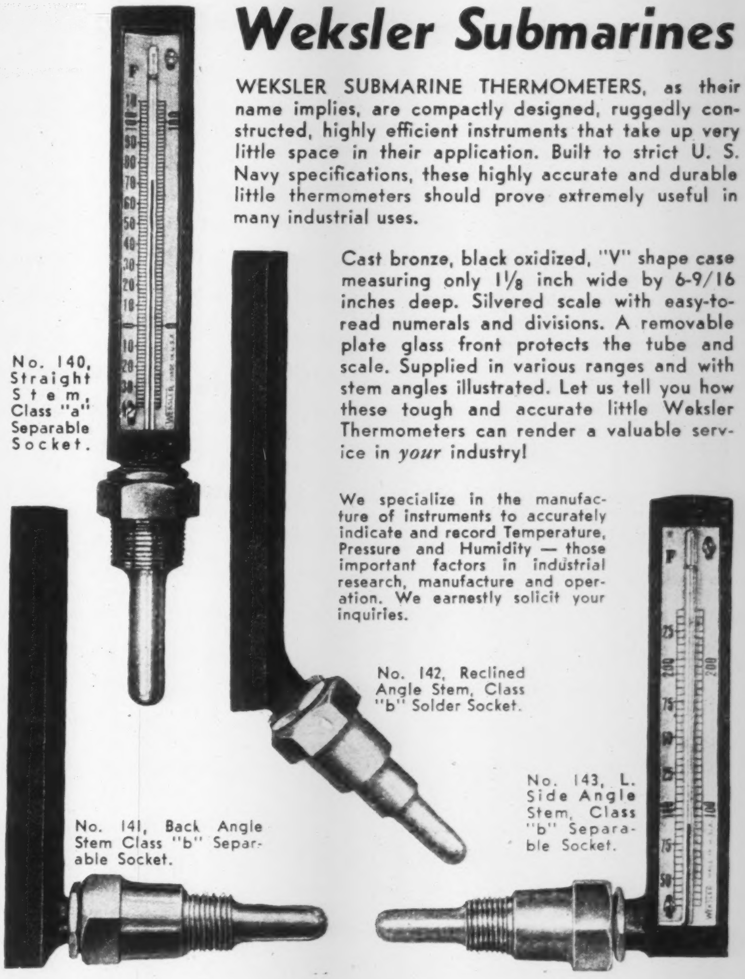
New "Model PA 156-B" crankshaft alignng fixture is designed to check alignment of rankshafts on aircraft engines not designed ith the internal spline feature, and for checking alignment of aircraft propeller shafts and assembled aircraft engine crankshafts. It is said to be a precision instrument, with every component part closely fitted and firmly assembled for consistent accuracy in testing. Crankshaft in fixture is always free to rotate for concentricity checking. Dimensions: 36" long, 6" wide, 13" to top of bearing mounted V-blocks.—*Airplane Mfg. & Supply Corp., Mfg. Div., 6853 Lankershim Blvd., North Hollywood, Calif.*



Redesigned Magnetic Comparator

Redesigned magnetic comparator (see *Instruments*, April 1944, page 240) has a more functional arrangement of its components. New grey steel case has sloping front panel on which are located the indicating instrument, variable-voltage transformer,





INSTRUMENTS FOR INDUSTRY

Weksler Submarines

WEKSLER SUBMARINE THERMOMETERS, as their name implies, are compactly designed, ruggedly constructed, highly efficient instruments that take up very little space in their application. Built to strict U. S. Navy specifications, these highly accurate and durable little thermometers should prove extremely useful in many industrial uses.

Cast bronze, black oxidized, "V" shape case measuring only 1⅛ inch wide by 6-9/16 inches deep. Silvered scale with easy-to-read numerals and divisions. A removable plate glass front protects the tube and scale. Supplied in various ranges and with stem angles illustrated. Let us tell you how these tough and accurate little Weksler Thermometers can render a valuable service in *your* industry!

We specialize in the manufacture of instruments to accurately indicate and record Temperature, Pressure and Humidity — those important factors in industrial research, manufacture and operation. We earnestly solicit your inquiries.

No. 140, Straight Stem, Class "a" Separable Socket.

No. 142, Reclined Angle Stem, Class "b" Solder Socket.

No. 141, Back Angle Stem Class "b" Separable Socket.

No. 143, L. Side Angle Stem, Class "b" Separable Socket.

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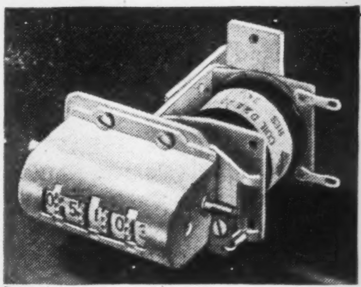

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Compact, sturdy, well-engineered. Mechanism entirely enclosed in cadmium-plated housing. Easy-to-read figures behind plastic window.

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Size 3⅛"x1⅝"x3⅛". Uses 115-v, 60-cycle. (adaptor for 6-v to 220-v, AC or DC, 75c extra). Draws 4 watts. Counts to 99,999 then repeats. Max. count speed 700 per min. Two types, NON-RESET, $4.10; RESET, $12.50. Mounting bracket, 26c extra.
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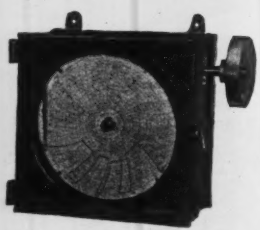

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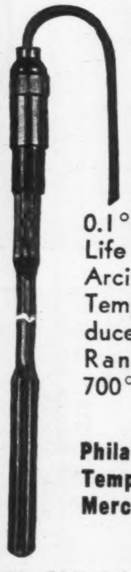

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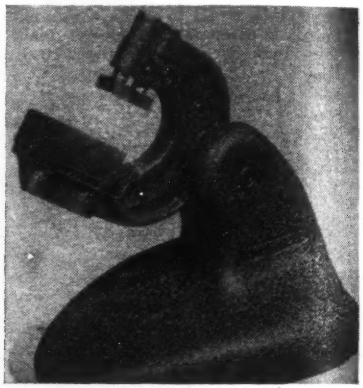
and the necessary rheostats and switches. Graduated dial plates on the sensitivity and balance control rheostats have been added to allow duplication of settings. In addition, a light indicates whether or not the power is on. Receptacles for making connections to the test fixtures and power source are now located at back of case, thus keeping wires out of operator's way and allowing a clear view of the indicating instrument. Redesigned instrument incorporates all the basic functions of the previous model. The circuit is balanced by placing an acceptable part in each of the two test fixtures. One of these parts is then removed and those to be tested are individually inserted. Any deflection of the instrument pointer indicates a deviation in magnetic characteristics from that of the standard. — *Special Products Div., General Electric Co., Schenectady, N. Y.*

Extended-anvil Snap Gages

New extended-anvil adjustable snap gages are said to offer many advantages in speeding up inspection and increasing production. Work is quickly aligned with gaging anvils. Smooth, even approach of gage to work eliminates uneven wear of lower anvil and prolongs its life. Extended anvil provides a stable bearing when presenting gage to work in a machine. As a hand gage, extended anvil snap enables inspection job to be done with less fatigue than with conventional snap gage. Used in a stand (see photograph) this type of anvil provides a platform upon which workpiece is located in presenting it to gaging position. A.G.D. locking devices are used on adjustable anvils. Square type anvils are furnished as standard—pin type anvils may be supplied on request. Twenty-five standard models cover the range 0.000″ to 6.625″ and also provide choice of two different height lower anvils. Larger sizes are available on special order.—*Sheffield Corp., Dayton 1, Ohio.*



Internal-dimension Comparator

New "Model N-5 Internal Measuring Instrument" is equipped with "Electrigage" amplifying device (2500 to 1) developed

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Portable Moisture Register shows moisture content on reading dial.

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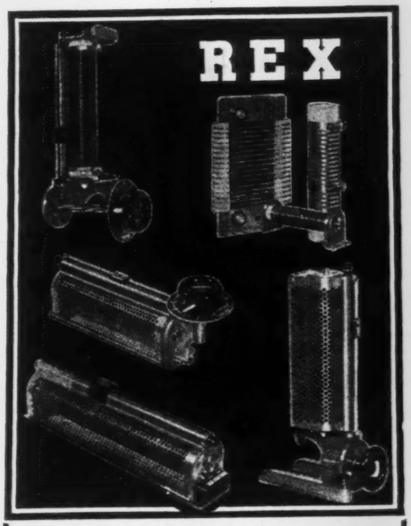

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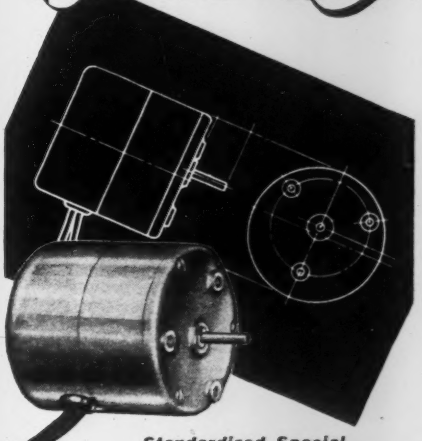

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As a result of 30 years specialization in the design and manufacture of special motors and gear motors of from 1/3000 to 1/3 h.p., SpeedWay has developed not only a vast store of "know how", but innumerable standardized units which can be assembled and wound in varying combinations to give shaded pole, shunt wound or series wound motors, engineered to exactly meet specified requirements of output, torque, space, speed and even cost.

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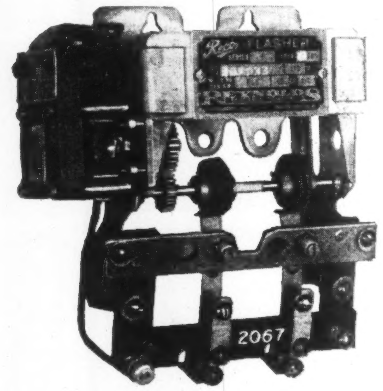
amplifications may be had on special order. Instantaneous action of indicator hand is claimed. Gaging pressure need never exceed three ounces. A fine adjustment knob is used in obtaining a zero setting. An automatic stabilizer prevents ordinary voltage variations from affecting accuracy of readings. Precision blocks or masters are used as a reference in setting up instrument. A limit switch arrangement operating two red signal lights assists operator in setting up and in properly positioning work for checking. Gaging range covers 0.270" minimum and 12" maximum gaging diameters. Surface plate is adjustable vertically. It is possible to explore a hole 3" deep throughout for diameter, taper, bell-mouth, and out-of-round conditions. Capacity is sufficient to accomodate an A.G.D. ring of the largest size. Instrument can also be supplied with special gaging arms for checking holes down to 0.240" diameter. Maximum gaging depth from surface plate to center of diamond points on these arms is 1". All critical and exposed parts are chrome-plated for longer life. Tungsten carbide is used at points of contact to minimize wear. Linear scale is of balanced type having a total range of 0.0012". Scale interval representing 0.00005" is approx. ⅛" so that interpolation to 0.000025" or less is easily accomplished.—*The Sheffield Corp., Dayton 1, Ohio.*

Automatic Timer

New "Reco Control Timer" was designed for controlling manufacturing operations in which starting is initiated by momentary-contact push-button, stopping automatically at pre-set time. It can also be equipped with interlocking controls so that each operation must be completed in correct sequence before the next is started. Failure at any point would post a signal and timer would re-cycle automatically to starting position. Example of applications is as hydraulic press control in which pressure valves are shut off upon reaching a certain tonnage, holding the pressure for pre-determined time and signaling the operator. Timer is equipped with silver contacts and has a two-circuit control. It has synchronous motor for operating on 115-volt 60-cycle a.c. However, when desired it can be ranged for other current specifications.—equipped with additional circuits and ar-*Reynolds Electric Co., 2623 W. Congress St., Chicago 12, Ill.*



Capacitors for High-Temperature High-voltage Uses

New "Type 25P" capacitors utilize maker's "Vitamin Q" impregnant, operate satisfactorily at thousands of volts at ambient temperatures as high as +105°C. to −40°C. resistance at room temperature is at least temperatures as high as 105°C. Leakage five times higher than that of previous types. New units are said to retain all of virtues of conventional oil-impregnated units throughout range of +105°C. to −40°C. Standard types include hermetically-sealed rectangular metal container capacitors in jointly by Sheffield and Westinghouse. Other

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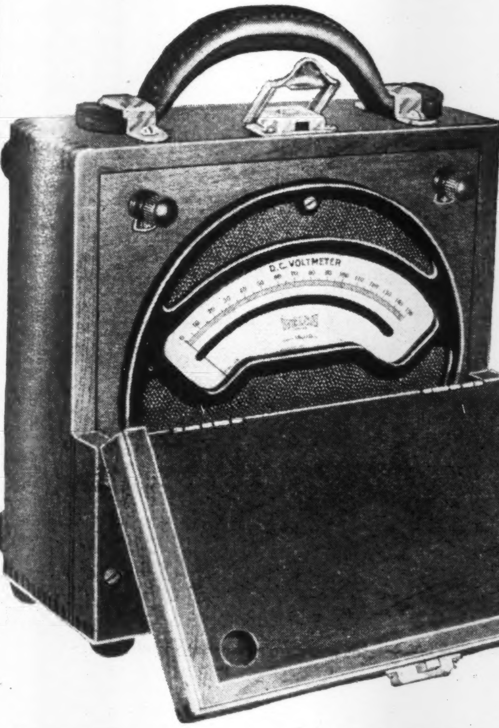

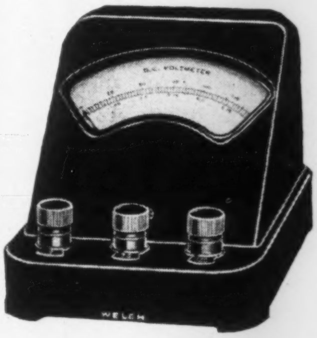

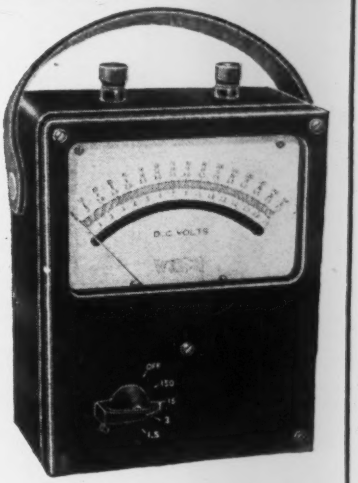

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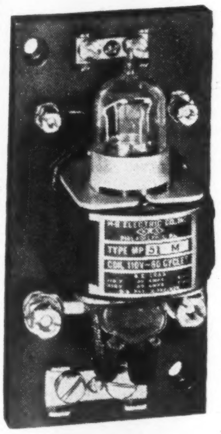

As a further refinement in the widely used H-B Mercury Plunger Relay, a new crown shaped wire guide holds the plunger straight and friction-free. A faster, cleaner break results. There is no prolonged arc—no mercury splash. Service life is prolonged.

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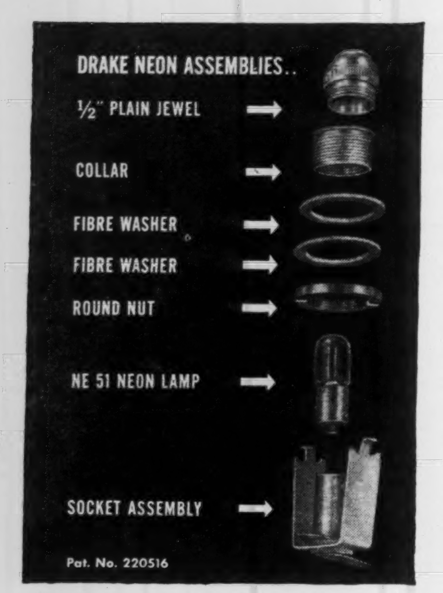

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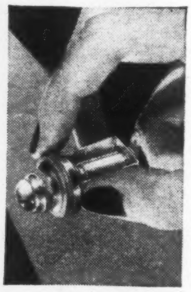

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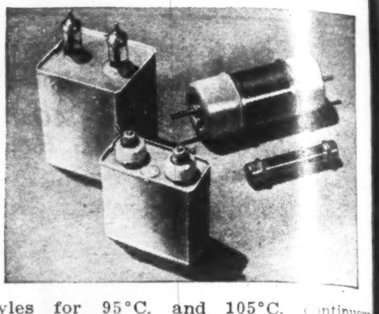
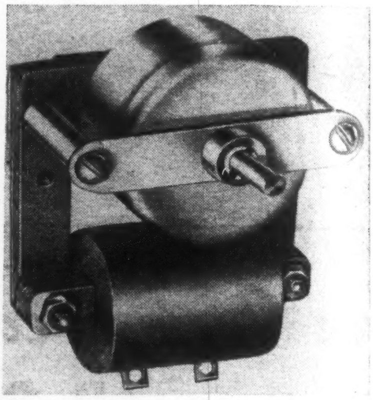


styles for 95°C. and 105°C. continuous operation, and in d-c. rated voltages from 1,000 to 16,000 volts. Other types include "Type 45P" hermetically sealed in glass shells with metal end caps. When used on jobs where high temperature is not a factor, new capacitors are said to result in materially higher ratings for a given size.—*Sprague Electric Co., North Adams, Mass.*

1-r.p.h.-terminal-shaft Motor

New timing and control motor with terminal shaft speed of one revolution per hour represents maker's first attempt to enclose within a sealed case a motor having a terminal shaft speed slower than one revolution per minute. It was designed to meet



demands for a slow-speed totally-enclosed motor for use in timers, thermostats, oil burner and coal stoker controls, and other apparatus in which minimum space and slow speeds are necessary. It can be furnished in other speeds up to and including six revolutions per hour. New motor has an input rating of 2 watts. A special oil gland built into terminal shaft bearing extends its life greatly under industrial and domestic operating conditions. Terminal shaft is concentric with outer case of motor. A companion model having a terminal shaft speed of three revolutions per hour has an eccentric terminal shaft placed normally in the 12 o'clock position nirespect to outer case. This design can also be furnished at speeds of 3 r.p.m. to 6 r.p.m. Production samples of both designs will be available when maker's war production eases.—*Warren Telechron Co., Ashland, Mass.*

Thread Gage

New "Thredchek" is said to make possible a more complete check of threaded parts. It utilizes principles of indicator snap gage and of thread roll-snap gage. It has a standard balanced type large indicator graduated in 0.0001"; and its top NO GO roll is not fixed —its movement actuating the indicator, showing how low or high is the pitch diameter. A free rotating backstop, enabling the part to be properly located when presented to the NO GO rolls, eliminates possibility of "cocking." No trained sense of "feel" in making the NOT GO check is needed. If a part passes the GO rolls, the lead, thread angle, and pitch diameter are shown to be within maximum tolerance limits and the

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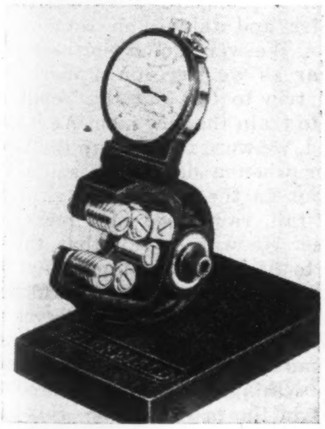
part will assemble. Indication of the pitch diameter when the part is presented to the NO GO rolls separates check of pitch diameter from check of lead. If pitch diameter is correct, then it is known that lead is correct. Correctness of form or angle can be checked visually as part is passed through full thread form ribs of GO roll. When part is rotated in contact with NO GO rolls, indicator shows any out-of-round condition. Instrument can be placed in standard thread roll-snap stand and used at bench for checking of production parts. It also constitutes a convenient hand gage for checking threaded work at or in machine; or it may become an accessory to the visual gage. Full manufacturing tolerances can be utilized in production when work is checked with a "Threadchek." No allowance for wear is necessary as this is compensated for by adjusting the rolls on their eccentric pins.—*Sheffield Corp., Dayton 1, Ohio.*



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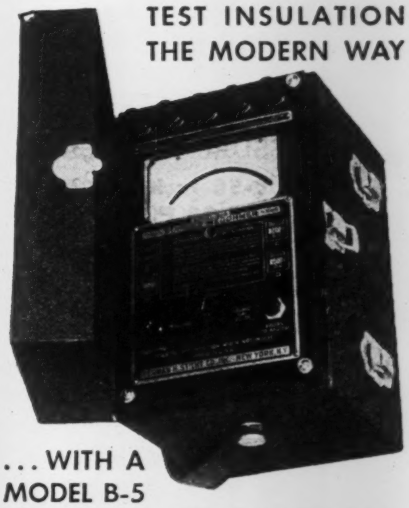

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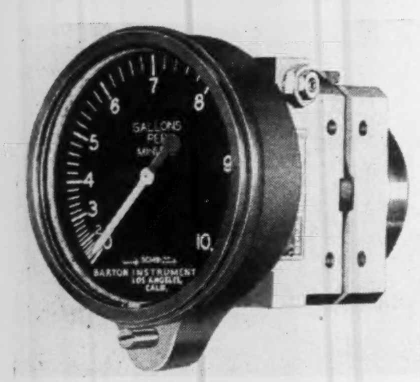

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for measurement of

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of hydraulically driven equipment

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INSTRUMENTATION SPELLS PROGRESS

Continued from Page 215

plying instruments as fast as they are developed and are sure of their operation. In the laboratories there are many pieces of unique apparatus and ingenious instrumentation to help the chemist. However, because of the limited amount of chemicals produced and because human manipulation makes duplication of batches a comparatively simple procedure, instrument control is not as important in the laboratory as it is in plant production. In plants which may stretch over acres of ground, instruments are the important control of the intricate travel of chemicals in their manufacture. Therefore, we of management consider it wise and thrifty to instrumentize wherever possible and employ experts to advise and keep in repair the installed automatic controls and measuring devices about our operations. Present-day speed-up in production and the return in post-war days of keen competition demand that we avail ourselves as far as possible of the instruments which can be used advantageously.

Instrumentation is Progress; and as we look back upon what it has done we see multitudinous contributions to safety. Cleanliness, better working conditions, even more pay and leisure time for employees. Through the aid of control instruments we have in many cases been able to put processes out of doors with only the controlling instruments housed. This has led to greater safety and economy in operation as it entirely eliminates any danger of inflammable gases being collected and does away with the large investment in buildings. Some day, through instrumentation, the Chemical Industry may be all out of doors—at least a greater portion thereof.

The uninitiated might feel that when we in the Chemical Industry use instruments in our distillations, filtrations, evaporations, drying and even bulk weighings, the number of unemployed will increase. This is not the case. Instruments are still instruments. They must be watched, checked, repaired, and therefore humans, possessing the finest instrument of all, their brains, are still essentials. Time and human energy is saved, production is improved and increased and, in all, there will be more employment and less drudgery.

Monsanto's Chief Engineer says that in designing our latest plants, great emphasis and attention was given to proper instrumentation. He says that with instruments, chemical engineers are able to design continuous batch processes, that instruments permit uniform high-grade products and practically eliminate wastage and off-grade chemicals.

All of Monsanto's large plants employ full-time instrument men whose duty it is to advise the management on the development of new devices, suggest and supervise the installation of instruments and keep in perfect operation those already in service. The smaller plants have trained and experienced men who spend part of their time on this work in instrument supervision.

Monsanto today has as assets close to a million dollars invested in measuring and control instruments. The styrene plant in Texas, the first plant in America to produce one of the two basic materials of synthetic rubber, is as completely instrumented as was possible to make it. One quarter of a million dollars was invested in those instruments. Monsanto's phosphorus furnace plant, the largest electric furnace producer of this element in the world, is another example of control by instruments. In another new Monsanto plant located in Trenton, Michigan, a plant in which are made the products of peace now used for war, instruments were located and built into the complete and modern operations. Monsanto has always prided itself in its stubborn adherence to a broad and strong research program which is a state of mind always open to new things and better ways of accomplishment. Instruments and expert instrument men naturally dovetail into that program.

We subscribe wholeheartedly to the reasoning of an English friend of ours who said, "The reason why we are on a more imaginative level is not because we have finer imaginations but because we have better instruments. In science one of the most important things that has happened is the advance in instrumental design."

In conclusion, I would like to tell you of a true story in which one of the instruments of the body — the nose — played its part. I was in command of the destroyer "Ammen." We had come out of Norfolk Navy Yard after some repairs and taking on some new recruits. We were going nowhere in particular as we were, on a more or less trial trip to test out the repair work and to train the new men. As it so happened, we were running up the Potomac River when a dense fog shut in. The lookout in the bow of the ship was a very tall, raw-boned new recruit from Texas. He was so tall that the Navy had to fit him out temporarily with a uniform, the trousers of which were well up his legs, and the sleeves of his jumper were nearly up to his elbows. He had been told to keep a sharp look for anything ahead. As we nosed up the river in the pea-soup fog, this lookout suddenly turned and hailed me on the bridge: "Say Cap, I smell hay," to which I replied: "If you smell hay we will anchor"—which we did. In the morning the fog had cleared. Sure enough, a short distance ahead of us was a field of new-mown hay. So you see one of the many reasons why I hold instrumentation in such high regard.

Thank you.

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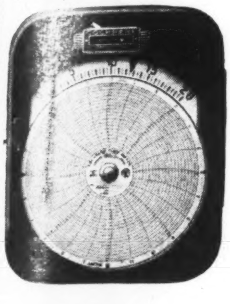
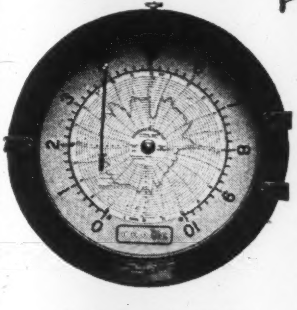
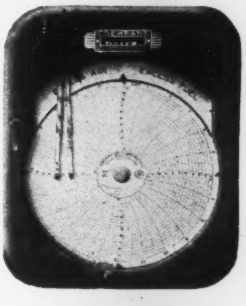


Electric Flow Meter
Null Balance Principle
Described in Publication 3010

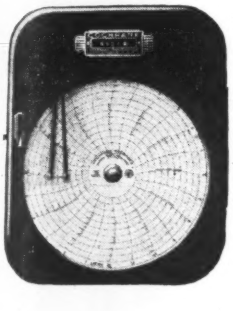


Mechanical Flow Meter
High Torque—Tilting U-Tube
Described in Publication 3010



Boiler Ratio Meter
Steam Flow—Air Flow
Described in Publication 4071

Liquid Level Meter
Friction-Free
Described in Publication 3010



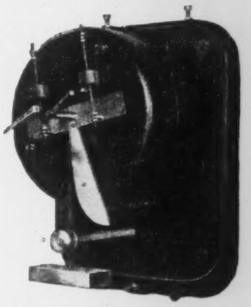
Temperature Recorders
Pressure Recorders
Described in Publication 3010

Described in Publication No. R-100A

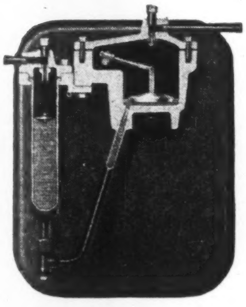
Free Float Rotameters

Described in Publication No. R-100A

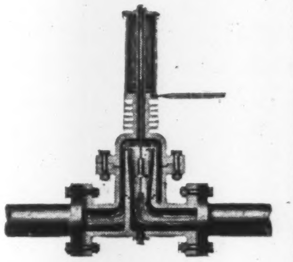
Guided Float Rotameters



Ring Balance Meters
Described in Publication 3010



Stationary U-Tube Meter
Described in Publication 3010



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Volatile Corrosive Fluids
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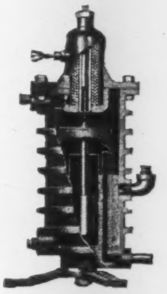

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Instrument Societies

"Declaration of Policy"

PREPARED BY THE COMMITTEE ON A CONSTITUTION
REPRESENTING THE INTERSOCIETY CONFERENCES
HELD NEW YORK DEC. 2, 1944; CHICAGO FEB. 17, 1945

R. C. Darnell, *Chairman*	Instrument Society of Washington
H. F. Moore	Society for Measurement and Control (New Jersey)
W. H. White	Philadelphia Society for Instrumentation

ADVISORY MEMBERS

C. O. Fairchild	New York Society for Measurement and Control
J. E. Gambrill	Philadelphia Society for Instrumentation
Richard Rimbach	American Society for Measurement and Control
W. A. Wildhack	Instrument Society of Washington

ARTICLE I—NAME

1. The name of this society is THE INSTRUMENT SOCIETY OF AMERICA.

ARTICLE II—GOVERNMENT

1. The control and management of the affairs, property and funds of the Society shall be vested in the Board of Directors.

2. Roberts' Rules of Order, Revised, where applicable, shall determine the conduct of business in all meetings of the society, its governing bodies and committees except when inconsistent with the Constitution and By-Laws of the Society.

3. All questions coming before the Society, its governing bodies and committees shall be decided by a majority of the votes cast except as otherwise provided by the Constitution and By-Laws.

ARTICLE III—OBJECTIVES

1. The objectives of the Society shall be to advance the arts and sciences connected with the theory, design, manufacture and use of instruments in the various sciences and technologies; to encourage research; to foster education in the instrument field; to advance the standards of science and engineering and to promote intercourse among its members and with allied technological societies, to extend and broaden the usefulness of the instrument profession.

ARTICLE IV—MEMBERSHIP

1. The membership of the Society shall consist of:

HONORARY MEMBERS
MEMBERS
STUDENT MEMBERS
SUSTAINING MEMBERS

ARTICLE V—QUALIFICATIONS FOR MEMBERSHIP

1. All members shall be elected by the Executive Council.

2. Any person, firm or institution interested in the objectives of the Society shall be eligible for membership.

ARTICLE VI—DUES OF INDIVIDUAL MEMBERS

1. The annual dues of individual members shall be:

HONORARY MEMBERS	None
MEMBERS	$7.50
STUDENT MEMBERS	2.00

2. The Society shall retain $2.50 of the dues of each MEMBER and $1.00 of the dues of each STUDENT MEMBER and the balance shall be refunded to the local chapter with which the member is affiliated. The entire dues of the members not affiliated with a local chapter shall remain in the treasury of the Society.

3. The following initiation fees shall accompany membership applications and shall be retained by the National Treasury:

MEMBERS	$2.50
STUDENT MEMBERS	1.00

4. The amount and distribution of the annual dues of MEMBERS and STUDENT MEMBERS may be changed by a two-thirds vote of the Board of Directors.

ARTICLE VII—OFFICERS AND THE EXECUTIVE COUNCIL

1. *Officers:* The officers of the Society and their term of office shall be:

President	1 year
Vice President	1 year
Treasurer	2 years
Executive Secretary	2 years
Directors	1 year

2. *Executive Council:* The Executive Council shall consist of the officers. One half the officers shall constitute a quorum.

ARTICLE VIII—ELECTION OF OFFICERS

1. Election of officers, other than Councilors, shall be by the incoming Board of Directors and shall be held at the Annual Meeting of the Society. All members of the Society, including those who are members of the Board of Directors, are eligible for election to office.

2. Councilors shall consist of the latest living Ex-President, the Chairmen of the different Divisions of the Society and such additional members as shall be determined and elected by the Board of Directors.

ARTICLE IX—BOARD OF DIRECTORS

1. The term of office of members of the Board of Directors, excepting ex-officio members, shall be two years.

2. Each local chapter having 50 or more members shall be eligible to elect one member to the Board of Directors. Local chapters having membership under 50 shall be represented as provided for Members at Large.

3. Members at Large who are not affiliated with any local chapter and Local Chapters having membership of less than 50 are entitled to representation on the Board of Directors in the proportion of one Director per 100 members. Such Directors shall be elected by the members without other representation and they shall be residents of the territory they represent.

4. The quorum of the Board of Directors shall consist of one half of its members including the ex-officio members.

ARTICLE X—AMENDMENT OF THE CONSTITUTION

1. Amendment of the Constitution may be proposed by a petition signed by twenty or more voting members of the Society or by a resolution adopted by the Board of Directors. The proposed amendment, with a statement of the reasons therefore shall be mailed by the Executive Secretary to all voting members. Voting may be either by letter ballot or by ballot at the Annual Meeting as shall be determined by the Board of Directors. If by vote at the Annual Meeting, the proposed amendment shall b mailed to the members at least 30 days be fore the time of the meeting. Adoption o the amendment shall be decided by a tw thirds majority of those voting at the an nual meeting or by a majority of the vot cast if by letter ballot. If by letter ballo the Executive Secretary shall deliver th ballots received to the Committee of Teller appointed by the Executive Council no sooner than 30 days after the mailing of th last ballot to the last member.

2. The Board of Directors shall amen the By-Laws so that they are in harmon with any amendment to the Constitution.

ARTICLE XI—INITIAL CHAPTER AFFILIATION

1. Local instrument societies duly o ganized by or before the date of the adop tion of this Declaration of Policy and th initiation of the Society shall pay to th Society an entrance fee of $10.00 if of 5 or more members, or $5.00 if of less tha 50 members. The local society may contrib ute more than the prescribed $5.00 or $10.0 at their own option.

2. Members in good standing of the lo cals affiliating with the Society shall pay n membership dues for the year ending De cember 31, 1945. Membership of the local chapters shall be taken to be that at th time of affiliation and shall be based upo a certified list furnished by the local wit the application for affiliation or within te days after the signing of this Declaration o Policy by the local's delegate.*

3. Persons becoming members of the So ciety after affiliation of a local with th Society shall pay dues for the balance o 1945 of $3.00, of which $2.00 shall be re funded to the local chapter with which th member affiliates. The dues for student members for the balance of 1945 shall b $1.00, all of which shall be returned to th local chapter.

4. Locals affiliating with the Society within 30 days of the adoption of this Dec laration of Policy shall be considered Char ter Member Chapters and their members a Charter Members of the Society. Members at-large and new members of local chapters joining the Society on or before December 31, 1945, shall also be considered Charter Members of the Society.

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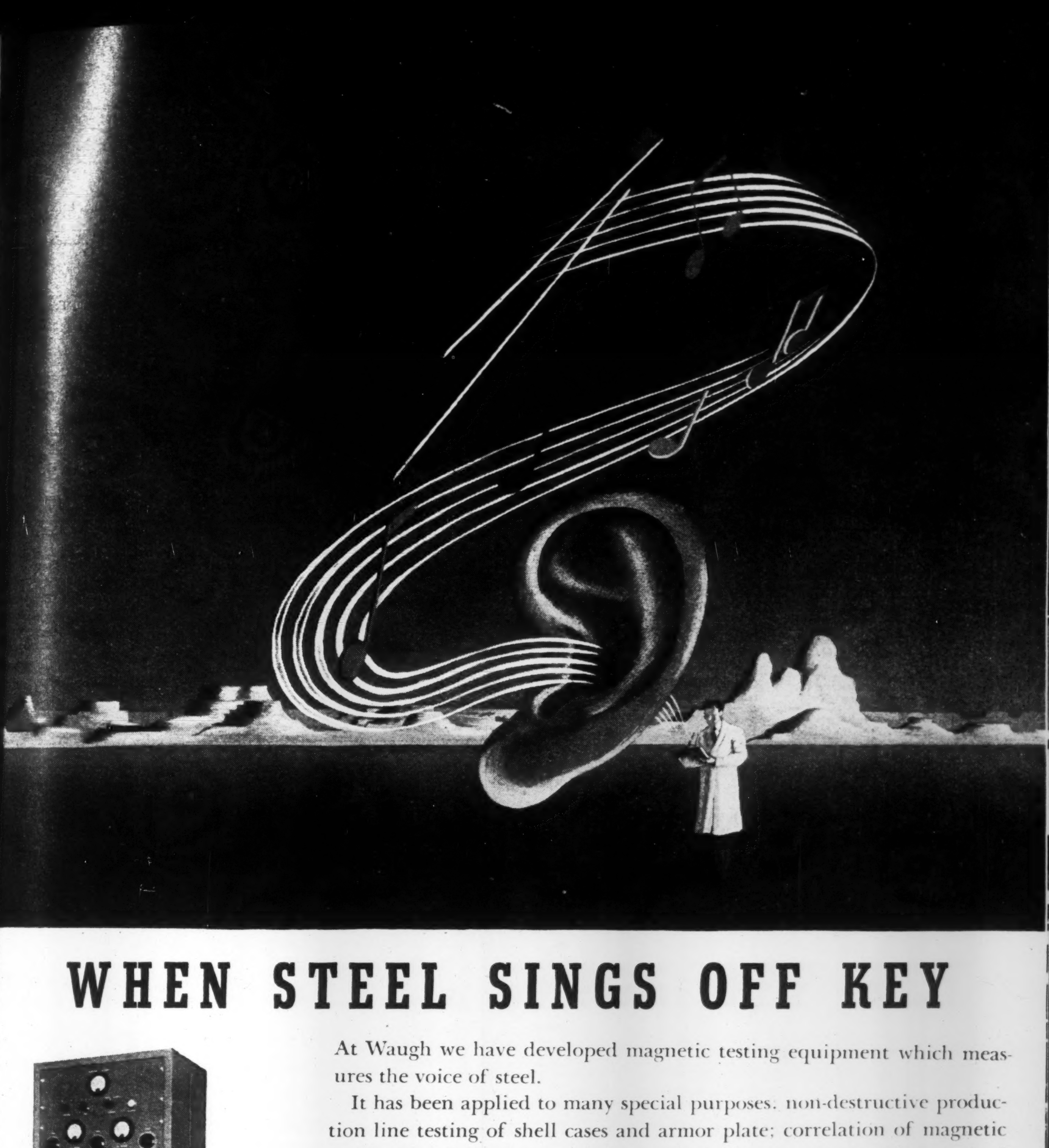
*Note: It is recommended that dues of members o local societies becoming payable before December 31 1945 be prorated to that date by the local chapter. All of such prorated dues should be retained in the local's treasury.

News of Local Societies

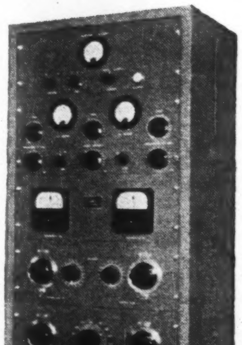
CHICAGO

The March 5th meeting of the Chicago Society For Measurement and Control was addressed by Mr. J. G. Ziegler of the Taylor Instrument Companies, whose subject was "Improve The Controlled Process." Mr. Ziegler pointed out that in laying out a control system, emphasis is usually placed on the operation of valves, temperature bulbs, diaphragms, and transmission systems, rather than on the process itself. Complaints of lag and hunting are usually directed at the control mechanism, instead of the process method.

According to Mr. Ziegler, many of the demands put upon controllers would be unnecessary if modifications were made in the process. He cited numerous examples where a change in the size of a tank, a reversal in operation, or a new location of a primary measuring element responding to a variable would, to a large degree, eliminate the objectionable hunt, or lag attributed to the controls.



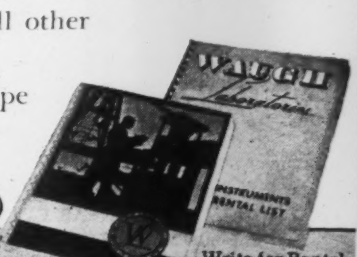
WHEN STEEL SINGS OFF KEY



At Waugh we have developed magnetic testing equipment which measures the voice of steel.

It has been applied to many special purposes: non-destructive production line testing of shell cases and armor plate; correlation of magnetic readings with hardness and change in grain structure; sorting steel of various grades. It has spotted trouble where all other instruments have failed.

This instrument is the Waugh Induflux, Type F. If steel presents unsolved problems, write for details.



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WAUGH Laboratories

Above: WAUGH INDUFLUX, TYPE F

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INSTRUMENT SOCIETIES CALENDAR

City, Society and Secretary			Date	Place	Subject	Speaker
Atlanta, Georgia	Georgia Society for Measurement & Control	Robert E. Geminert, P.O. Box 1714, Atlanta				
Baltimore, Maryland	Baltimore Industrial Instrumentation Society	J. J. Seglets, 35 S. Potomac St., Baltimore 24		Engineers Club, 6 W. Fayette St., Balto.		
Chicago, Illinois	Chicago Society for Measurement & Control	A. J. Butler, c/o IHC, 2626 W. 31st Blvd., Chicago	May 7(B)	M&M Club, 237 Merchandise Mart	Unusual Boiler Control Applications	P. N. Mann, Bailey Meter Co.
Cleveland, Ohio	Cleveland Instrumentation Society	W. A. Stubblefield, 2085 W. 104th St., Cleveland 2	Apr. 25(B)	Cleveland Engineering Society	Potentiometers	S. G. Flack, Leeds & Northrup Co.
Detroit, Mich.	Instrument Society of Detroit	Cliff Sackett, Chrysler Eng'g 12800 Oakland Ave. Det't		(To be announced)		
Fort Worth, Texas	Fort Worth Electronics Club	Ralph Ely, 1116 E. Arlington, Fort Worth	Apr. 19(A)	Texas Hotel, Fort Worth	Tie-line Load Control	H. R. Newth, Texas Electric Co.
Gulf Coast (Texas)	Gulf Coast Instrument Maintenance Men's Ass'n	T. H. Pierson, 3030 Roberts St., Beaumont, Texas				
Hartford, Conn.	Hartford Society for Measurement & Control	S. J. Zelle, Bridgeport Thermostat Co., 1225 Connecticut Ave., Bridgeport, Conn.	Apr. 17(B)	Bond Hotel	Instruments in Crime Detection	Speakers from Conn. State Police
			May 15(B)	Bond Hotel	**Automatic Temperature Control**	**C. O. Fairchild, C. J. Tagliabue Div.**
Kansas City, Missouri	KC Industrial Instrumentation Society	Gordon H. Burke, 1527 Broadway, Kansas City, Mo.	Apr. 24(B)	Bluebird Cafeteria	Time Cycle Control and Applications	A. A. Blackman, Bristol Co.
Los Angeles, Calif.	California Instrument Society	M. D. Pugh, 2989 Lincoln Ave., Altadena, Calif.	May 1(C)	Hotel Mayfair, Los Angeles	(To be announced)	
Newark, N. J.	Society for Measurement & Control (New Jersey)	Robt. H. Gray, 1 Whippoorwill Way, Mountainside, N.J.	May 1(B)	Essex House	Influences Affecting Valve Characteristics	C. E. Mason, Bristol Co.
New York, N. Y.	New York Society for Measurement & Control	H. L. Hildenbrand, 206-07 33d Ave., Bayside, L.I., N.Y.	Apr. 24(B)	Columbia U. Men's Faculty Club, 400 W. 117th St.	Inspection Applications of X-rays	R. W. Mayer, Kelly-Koett Mfg. Co.
N. Indiana	Northern Indiana Soc. for Measurement & Control	K. M. Frame, 25 Ruth St. Hammond, Indiana	Apr. 20(B)	Lake Hotel, Gary	Oil Refinery Instruments	J. J. Connelly, Engr. Cities Service Oil Co.
Philadelphia, Pa.	Philadelphia Society for Instrumentation	G. E. Gress, c/o ATC, 34 E. Logan St., Philadelphia	Apr. 18(B)	Engineers Club, 1317 Spruce St.	Instrument Maintenance	Earl Nuneviller, Brown Instrument Co.
Pittsburgh, Pa.	American Society for Measurement & Control	L. M. Susany, c/o Carnegie Institute, 4400 Forbes St., Pittsburgh 13	Apr. 23(B) May 28(B)	Roosevelt Hotel Roosevelt Hotel	**Surface Finish Instruments** **Process Control**	W. Mikelson, G.E. W. B. Heinz, Cochrane
St. Louis, Mo.	St. Louis Society for Instrumentation	Gus Holubeck, Union Electric Co., Venice, Ill.				
Toronto, Ontario	Canadian Society for Measurement & Control	T. C. Agnew, Minneapolis-Honeywell Reg. Co.		Diana Sweets, 188 Bloor St. W., Toronto		
Washington, D. C.	Instrument Society of Washington	W. A. Wildhack, National Bureau of Standards, Wash'n	Apr. 17(D)	Interior Dep't Auditorium	Frequency Generator Applications	C. H. Fetter, Am. Time Products Corp.
Whiting, Indiana	Whiting Instrument Men's Guild	Lloyd Clouse, 7344 Dante Ave., Chicago 19, Illinois	Apr. 25	(To be announced)		
Wyandotte, Mich.	Instrument Society of Wayne County	D. J. McCloskey, 116 Oak St., Wyandotte, Mich.	Apr. 23(B)	West Mound Methodist Church	Special Hagan Control Applications	Arthur Borden

(A) Meeting at 7:30, no dinner **(B) Dinner at 6:30, meeting at 8** **(C) Dinner at 7, meeting at 8** **(D) Meeting at 8, no dinner**

If more engineers would be receptive to modifying their process systems as suggested by Mr. Ziegler, the performance of control systems would be materially improved. —G. R. THOMASON

DETROIT

The Instrument Society of Detroit had its first formal meeting on March 19, 1945, at the Research Laboratories of the Ethyl Corporation of Detroit. At this meeting, attended by representatives of many different industries, the basic organization of the society was discussed and agreed upon. The following officers were elected:

President, Wallace Perkins, General Motors Research Corp., 485 W. Milwaukee, Detroit, Michigan.

Vice President, Emil Gillig, Ethyl Research Laboratories, 1600 West 8 Mile Road, Detroit, Michigan.

Secretary-Treasurer, Cliff Sackett, Chrysler Engineering, 12800 Oakland Avenue, Detroit, Michigan.

It is planned to be able to send a representative to the April 28th meeting of the proposed National Society.

—CLIFF SACKETT, *Secretary*

KANSAS CITY

For our March 27 meeting of the Kansas City Industrial Instrumentation Society, Oliver L. Boutros of the Boutros Instrument Co. presented a basic lecture on the Wheatstone Bridge and Kelvin Bridge circuits. Oliver demonstrated that he was an old hand at instructing, and did a swell job of explaining the circuits as well as the advantages and disadvantages of both types of bridges.

Our Quiz Kids, Karl R. Bobb (North American Aviation), George Agin (Sheffield Steel Corp.), and Harold L. Emery (Phillips Petroleum Co.), were batting in their own home ball park and came out with an average of 1,000.

In order that all members would have a better understanding of the subject, a formal debate was conducted on the subject, "Why We Should be Affiliated with the Instrument Society of America." The affirmative side was carried by Robert S. Cook of Westinghouse Electric & Mfg. Co. and William A. Reichow of Minneapolis-Honeywell Regulator Co., while the negative side was carried by Lester Johnson of Sinclair Refining Co. and William G. Eargle of Phillips Petroleum Co.

After the debate an open discussion was held in which practically all of the members participated. It was decided that before any action was taken by our society, we would give every member an opportunity to read the "Declaration of Policy" which is to be published in the April 1945 issue of *Instruments.* —W. A. REICHOW, *President*

LOS ANGELES

The first regular meeting of the newly-organized California Instrument Society was held in the Rainbow Aisle, Mayfair Hotel, Los Angeles, on the evening of March 6th. About sixty-five attended the dinner with about eighty-five attending the business and technical session.

Through the courtesy of the Inspector of Naval Material, Vernon District, Los Angeles, a film was shown on the "Effect of High Impact Shock on Electrical Equipment." Running comments were made by Lt. E. J. King, U.S.N.

Following the showing of the film Mr. E. T. Schrotzberger of Applied Research Laboratories, Glendale, Calif., gave a very interesting talk on the "History and Development of the Microphotometer for Spectrographic Analysis." Mr. Schrotzberger traced the history of the Microphotometer from the earliest microscope to the latest developments. —M. D. PUGH, *Secretary*

NEW YORK

At the regular meeting of the New York Society for Measurement of Control on March 1, dinner was served to 51 members and guests.

Past-President Fairchild reported on the meeting held in Chicago February 17th for discussing the organization of a National Society, at which he represented our Society. The next meeting of delegates will be held in Pittsburgh April 28. The Chicago meeting confirmed the belief that the National Society is a good thing in itself and will benefit local Societies. Mr. Fairchild and President Kayan plan to send out to each member of the New York Society a statement of the policy of the National project so that it can be voted at our next meeting, March 27.

Mr. Rimbach, President of the Instruments Publishing Co., Pittsburgh, stated that the convention and exhibit scheduled by the Pittsburgh Society for next September is still a live issue and that at present, about 66 booths have been sold, out of about 91 booths. It is not yet known what position the ODT will take with respect to permitting conventions for next September.

William H. Offenhauser and Henry Lester then took over the meeting with an exceptionally absorbing lecture on High Speed

Photography in the Research Laboratory. Both men presented a wealth of detail which was worked up into a most valuable contribution to the technique of measurements of this unusual type. In it the high-speed camera stands out as the *time microscope* which magnifies motions which cannot be followed by the eye because of the rapidity with which such motions take place.

H. L. **Hildenbrand**, *Secretary*

PITTSBURGH

The March regular meeting of the American Society for Measurement and Control, held on the evening of March 26 at the Roosevelt Hotel, was addressed by Clark E. Hague, Cleveland District Manager of the Askania Regulator Co. for the last fifteen years, who substituted for Wilbur Pray, of Askania's main office in Chicago, who was ill-health. Mr. Hague had so carefully prepared his dissertation on "How to Get the Most Out of Your Automatic Controls" that he read it in less than a half hour. It was so well received that, as soon as the meeting was over, Major Behar got Mr. Hague's manuscript for possible (or probable) publication in *Instruments*.

The two reels of sound films on manufacture of optical glass, by the Bausch & Lomb Optical Co., were also well received.

The dinner attendance was fifty-five and there were more than 105 members and guests at the technical session.

—L. M. **Susany**, *Secretary*

WASHINGTON

The March meeting of the Instrument Society of Washington was addressed by Mr. A. Tompkins of the Eastman Kodak Co., on the topic "The Use of Photographic Recordings in Instruments."

Mr. Tompkins presented a lucid discussion of the types of instruments in which photosensitive materials are used for recording transient phenomena, the characteristics of the photographic materials available, and gave many helpful hints on how to obtain successful recordings.

Following his talk, a movie was shown which described the Eastman M-3 high-speed camera and its applications.

—W. A. **Wildhack**, *Corresp. Secretary*

WHITING

The Whiting Instrument Men's Guild
Studying the Theory, Arts, and Practices of Measurement and Control as Applied in the Oil Industry

Whiting, Indiana

To the Editor of *Instruments*: Last September the Instrument Department employees of the Standard Oil Company of Indiana formed a society to study the instrument problems peculiar to our plant organization. We thought others in the instrument field might be interested to hear of it.

Due to the fact that a number of our men are on shift work, we have scheduled our meetings four weeks apart. This enables a shift man to attend two out of three meetings.

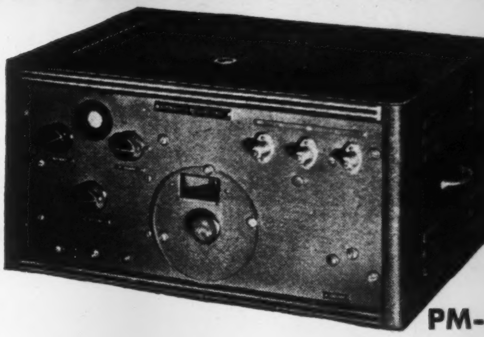
Our work is closely allied with that of the process department so our program includes talks on process as well as instruments and their application. Since membership in the Guild is limited to the men in our plant department, we are able to discuss items of interest to only our group. The principal aim of our society is the education of our members to enable us to do our work more efficiently.

The officers elected for the 1944-45 season are as follows:

President, Wilson P. Harmon;
Sec'y Treas., Archie W. Judson, Jr.;
Corresponding Sec'y., Lloyd Clouse.

The subject of our March 28 meeting was "Fluid Catalytic Cracking." Mr. Bauman of the Standard Oil Research Department gave the talk. He illustrated his lecture with slides of simplified flow diagrams and the instrumentation of the process. We count this meeting one of our most satisfactory, due principally to the clarity of Mr. Bauman's explanations.

—Lloyd **Clouse**, *Corresp. Secretary*



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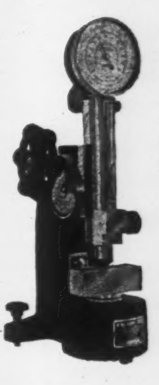

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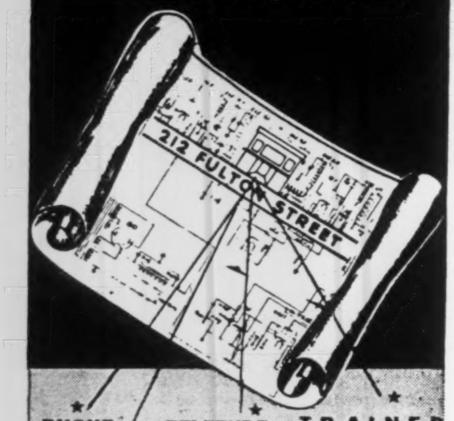

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from th manufacturers. To assist in the War Effort we urge readers to request ONLY those bulleti which will be of value to them. Use the coupon on the facing page.

M-97 **"The Laboratory."** The 24-page 6" × 9" issue (identified as Vol. 15, No. 2) of this house organ features the following articles: (1) Science has major role in progress of aerial warfare, (2) New combustion furnace employs latest type heating elements, (33) Labels permanently protected by new plastic glaze, (4) Castaloy jumbo hosecock has unique design features, (5) "Silicones" open entirely new fields of chemistry, (6) New method for determining phosphates in boiler water, and (7) Restrictions on laboratory instruments modified by W.P.B. Fisher Scientific Co., 717 Forbes St., Pittsburgh, Penna.

M-98 **Ground Testing of Lightning Rods and Arresters.** 4-page 8½" × 11" "Factory Mutual Bulletin of Loss Prevention," August 1944, No. 15.66 describes three methods of determining ground resistance with schematic diagrams of connections and lists safe and reliable low resistance ground connections with proper method of installation. James G. Biddle Co., 1211-13 Arch St., Philadelphia 7, Pa.

M-99 **Surface Inspection Instrument.** 4-page 8½" × 11" leaflet illustrates and describes the Soetbeer Inspectoscope, Model S-1, used for inspecting microscopically internal and external surfaces of objects and parts of machinery during and after completion of manufacture. Especially adapted for inspection of internal surfaces in aircraft engine cylinders, tubular and other hollow objects in which internal surfaces ordinarily are not accessible for visual inspection and observation. Internal Surface Projector Company, Mineola, N. Y.

M-100 **Plugs, Sockets, Terminals, Terminal Strips.** 36-page 8½" × 11" Catalog No. 14 illustrates numerous types of products, gives descriptions and dimensional drawings and includes current prices. Howard B. Jones Company, 2460 W. George St., Chicago 18, Ill.

M-101 **Electric Relays and Controls.** 4-page, 8½" × 11", circular describes relays, switches, capacitors, terminals and coils for electrical, electronic and industrial applications. Relays available for a.c. or d.c. from 3 to 115 volts, switches up to 10 leaves and 10-amp. capacity, capacitors from 5 to 140 mmf. Illustrated with photographs. Comar Electric Co., 3150 N. Eashtenaw Ave., Chicago, Ill.

M-102 **Electronic Test Equipment.** 5-page broadside folding to 8½" × 11", describes and illustrates with photographs four test units made by this manufacturer: (1) Characteristic test set for receiving-type tubes, (2) Cathode-ray test unit, (3) Noise test unit (strip recording of a-f. and r-f. noise levels under dynamic tube conditions), (4) Life rack (Cathode-ray, pulse or oscillation life racks). Sherron Electronics Company, 1201 Flushing Ave., Brooklyn 6, N. Y.

M-103 **Laboratory Equipment.** 64-page, 8" × 11¼", Catalog Supplement, covers a number of general laboratory apparatus and equipment with illustrations, specifications, price list and alphabetical index. Equipment described for first time by this manufacturer includes: balance with Stellite knife edges, combustio tube furnace, glass-working tools, meta lurgical testing equipment, voltage co trols, cold-handle sterilizers and Tygo flexible tubing. Scientific Glass Appa ratus, 49 Ackerman St., Bloomfield, Ne Jersey.

M-104 **Adjustable Triangle.** 6-page 3½ × 6¼", leaflet, pictures and describe Bruning adjustable and transparent tr angle No. 2598A having a base dimensio of 6¾" and altitude of 7-9/16". Can scri any angle from 0° to 90°. Adaptable f drawing screw threads, helical springs bevel gears. Charles Bruning Compan Inc., 4754 Montrose Ave., Chicago 4, Il

M-105 **"Precision" Safety Heaters.** page, 8½" × 11", Bulletin No. HP-165 pictures and describes safety heate having nickel-chrome heating coil ope ating on 110 volts a.c. or d.c. up to maximum temperature of 700°F. Uni are available with Transite covers an are suitable for heating complex glass ware set-ups involving distillation co umns, cumbersome flasks, delicate reflu condensers and other costly glasswar Also included is a temperature chart an table covering flask sizes, dimensions an prices. Precision Scientific Co., 1750 Springfield Ave., Chicago 47, Ill.

M-106 **Aircraft Products.** 24-page, 8½ × 11", booklet entitled "Lear Know-How illustrates and describes linear and ro tary actuators and power units, motor "Fastop" electromagnetic clutch, flexibl power shafting, screw jacks, automati and remote controls, gears and radi equipment. Each item available in sev eral sizes and is illustrated by photo graphs and cut-away views. Present an some possible future applications ar suggested by manufacturer. Lear Incor porated, Piqua, Ohio.

M-107 **Transformers and Chokes.** 4 page, 8½" × 11", leaflet, pictures trans formers and chokes for experimental an short-run purposes. Manufacturers buil transformers from fraction of a watt t kilowatts and chokes from 0.02 henries to 8 henries. Wyse Laboratories, Dayton 2, Ohio.

M-108 **Polariscope.** 4-page, 8½" × 11" circular pictures and describes a photoelastic polariscope for stress determination. The light source and polarizer are mounted on one section and the analyzer and projection system on the other permitting use of loading frame. Units are available in two sizes, one having 4½" aperture and the other 8½". Polarizing Instrument Co. Inc., 41 East 42nd St. New York 17, N. Y.

M-109 **"General Radio Experimenter."** 12-page, 6" × 9¼", January-February 1945 issue of this house organ features two articles: (1) Corrections for Residual impedances of the Type 821-A Twin-T Impedance Measuring Network and also (2) General Radio Pulse Generator. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

M-110 **Pressure Gage.** 4-page, 8½" × 11", circular pictures and describes the "Certified" gage with helicoid movement operating principle. Cut-away views and eneral specifications are included. Cer-fied Gauge and Instrument Corp., 34-18 orthern Blvd., Long Island City 1, N. Y.

M-111 Viscosimeter. 4-page, 8½" × 11", ulletin UV-[illegible] illustrates and describes bbelohde Viscosimeter which operates n the suspended level principle for the etermination of the kinematic viscosity f viscous liquid, such as petroleum prod-cts or lubricants. Also includes descrip-on of [illegible] Simmons' Modification which corporates the principle of the Ubbe-ohde Suspended Level Viscosimeter in a apor Jacket. Tables with size of capil-aries, approximate viscosity range and rice list are also included. Fish-Schur-an Corp., 230 East 45th St., New York 7, N. Y.

M-112 **"Bakelite Review."** 28-page, 8½" × 11", Vol. 16, No. 4, January issue of this ouse organ contains the following arti-les: 1. "Stepping into Tomorrow" (Ef-ects of vinyl plastics on shoe design and olor-style.) 2. "Fire-retardant wood and Plywood" (Tests, properties, and uses of re-retardant lumber.) 3. "Sea Seals" (A pecial water-resistant tape protects war atériel.) 4, "Elastic Plastics—Today and Tomorrow" (uses and properties of elas-ic vinyl chloride-acetate compounds.) 5. "Sound in an Envelope" (Vinyl disks add o the efficiency and sound-recording.) 6. "Ideas Are Ammunition Too" (An air-raft ammunition box molded from Bake-ite phenolic resin board.) 7. "It Belongs o the U.S.A." (Labels made from vinyl esins are ironed—not sewed—onto G.I. hirts.) 8. "A new note in Plastics" (The olystyrene harmonica may introduce a ew industry to America.) 9. "Defeating Corrosion and Contamination" (Contain-rs and their contents are protected by vinyl coatings.) 10. "Keep It Dry" (An emergency kit for Navy fliers is made esistant to water, sun, wind, and fungi y the use of vinyl resins.) Bakelite Cor-poration, 30 East 42nd St., New York 17, N. Y.

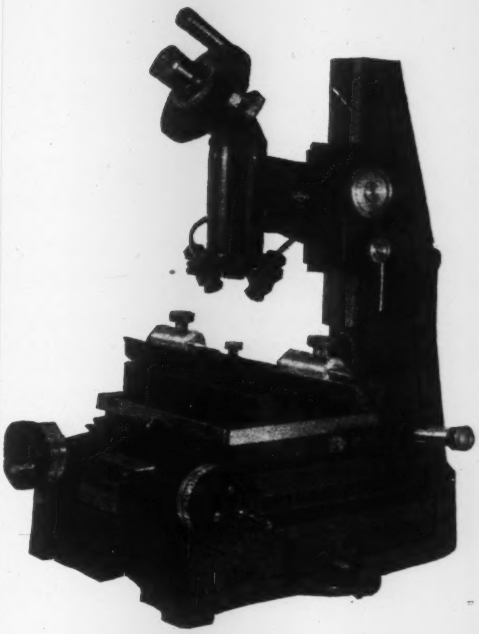
M-113 **Time Delay Relay.** 2-page 8½" × 11" Bulletin No. 3100 pictures and de-scribes a relay suitable for radio trans-mitter, radar equipment and industrial pplications. Bulletin includes construc-tion details, dimensional drawing, wiring diagram and time range data. R. W. Cramer Co., Inc., Centerbrook, Conn.

M-114 **Portable Electric Testing In-strument.** Single sheet 8½" × 11" de-scribes and gives specifications of Model PB-200 "Speed-O-Meter." Instrument measures a-c. and d-c. voltages, direct current to 1.5 amps, capacity to 30 mfd, decibels to +58 db, resistance to 2 meg-ohms. Superior Instruments Company, 227 Fulton Street, New York 7, New York.

M-115 **"Fairchild News."** 12-page 9" × 12" Vol. VIII, No. 3 February issue of this house organ features an article, "Fairchild reviews progress of a quarter of century." Fairchild Camera & Instru-ment Corporation, 475 Tenth Ave., New York 18, New York.

M-116 **"Rotaweirs."** 8-page 8½" × 11" Catalog Section 90-A describes and illus-trates a F. & P. Rotaweir used in con-tinuous distillation units for automat-ically splitting flow from condensers into any desired proportions without restric-tion of flow. Operating principle, con-struction details and cutaway views are included. Descriptions of Specific Grav-ity Testers, Product Gages & Tail Boxes and "Super-Clear" Filter used for filter-ing gasolines, solvents and light oils are also included. Fischer & Porter Co., Hat-boro, Pa.

M-117 **"Electronic Duo-Stat."** 14-page 8½" × 11" Catalog Bulletin No. 396A Edi-tion No. 1 presents features of weather-compensated heat regulator applicable to buildings heated by steam or hot water. Publication includes technical informa-tion, installation data, specifications, dia-grams for various types, hook-ups and firing devices, photographs of unit and



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